

INFORMATION  
ONLY

Controlled Copy No. 665  
21100-WP-OU 05.1  
VOLUME III



# PHASE I RFI/RI WORK PLAN FOR OPERABLE UNIT 5 Woman Creek Priority Drainage



VOLUME III - Text to Technical  
Memorandum No. 15 - Amended  
Field Sampling Plan (Vol. I - Text)

AUGUST 1994

ADMIN RECORD

A-OU05-000236

ROCKY FLATS	Manual No.:	21100-WP-OU 05.1
FINAL PHASE I RFI/RI	Procedure No.:	Table of Contents, Rev 5
WORK PLAN FOR OPERABLE UNIT 5	Page:	1 of 2
WOMAN CREEK PRIORITY DRAINAGE	Effective Date:	08/26/94
	Organization:	Environmental Management

## TABLE OF CONTENTS

### ROCKY FLATS PLANT FINAL PHASE I RFI/RI WORK PLAN WOMAN CREEK PRIORITY DRAINAGE OPERABLE UNIT 5

#### VOLUME I

<u>Section No.</u>	<u>Title</u>	<u>Rev. No.</u>	<u>Effective Date</u>
	Detailed Table of Contents		
ES	Executive Summary	1	02/24/92
1.0	Introduction	1	02/24/92
2.0	Preliminary Site Characterization	1	02/24/92
3.0	Applicable or Relevant and Appropriate Requirements	1	02/24/92
4.0	Data Needs and Data Quality Objectives	1	02/24/92
5.0	Phase I RCRA Facility Investigation/ Remedial Investigation Tasks	1	02/24/92
6.0	Schedule	1	02/24/92
7.0	Phase I Field Sampling Plan (FSP)	1	02/24/92
93-DMR-ERM-0034	Modifications to Section 7	1	01/12/94
8.0	Baseline Health Risk Assessment Plan	1	02/24/92
9.0	Environmental Evaluation	1	02/24/92
10.0	Quality Assurance Addendum	1	02/24/92
94-DMR-ERM-0003	Elimination of Daily Inspection	1	01/10/94
11.0	Standard Operating Procedures and Addenda	1	02/24/92
12.0	References	1	02/24/92

ROCKY FLATS

Manual No.:

21100-WP-OU 05.1

FINAL PHASE I RFI/RI

Procedure No.:

Table of Contents, Rev 5

WORK PLAN FOR OPERABLE UNIT 5

Page:

2 of 2

WOMAN CREEK PRIORITY DRAINAGE

Effective Date:

08/26/94

Organization:

Environmental Management

VOLUME II

<u>Section No.</u>	<u>Title</u>	<u>Rev. No.</u>	<u>Effective Date</u>
APPA	Appendix A: As Built Drawings for Pond C-2		
	C-2 Dam-General Plan, D 27165-231	A	11/20/79
	C-2 Dam-Cutoff Trench Plan and Dam Profile D 27165-232	A	11/20/79
	C-2 Dam-Embankment & Spillway Details D 27165-235	A	11/20/79
	C-2 Dam-Outlet Works, D 27165-236	A	11/12/80
	Outlet Works Inlet Structure & Pipe Details D 27165-241	A	11/12/80
	Outlet Works Outlet Structure, D 27165-242	A	11/12/80
APPB	Appendix B: In Situ Radiological Survey of the Old Landfill	0	08/22/91
APPC	Appendix C: Groundwater Analytical Data	0	08/22/91
APPD	Appendix D: Sediment Analytical Data	0	08/22/91
APPE	Appendix E: Surface Water Analytical Data	0	08/22/91
•TM 15	Technical Memorandum No. 15: Amended Field Sampling Plan (3 volume set)	0	08/26/94

RFI/RI WORK PLAN TECHNICAL MEMORANDUM  
APPROVAL SHEET

INFORMATION  
ONLY

EG&G ROCKY FLATS PLANT

Document Number:

21100-WP-OU05.1

Section: (Sect. #) (Rev. #)

Approval Sheet

Page:

1 of 1

Effective Date:

August 24, 1994

Organization:

ER OU 5.6 & 7 Closures

TITLE:

Operable Unit No. 5, Technical Memorandum No. 15  
Addendum to Final Phase I, RFI/RI Work Plan  
Ammended Field Sampling Plan  
Rocky Flats Plant  
Worman Creek Priority Drainage

Approved By:

EO Mosch  
OU5,6&7 Closures Program Manager

8 / 23 / 94  
Date

OUBA  
OU5 Project Manager

8 / 22 / 94  
Date

Steve J. [Signature]  
ER QA Program Manager

8 / 23 / 94  
Date

DOCUMENT CLASSIFICATION  
REVIEW WAIVER PER  
CLASSIFICATION OFFICE

LIST OF TABLES .....	iv
LIST OF FIGURES .....	v
LIST OF ACRONYMS .....	vi
1.0 INTRODUCTION .....	1-1
1.1 PURPOSE OF PROJECT .....	1-1
1.2 BACKGROUND .....	1-2
2.0 SUMMARY OF PHASE I FIELD INVESTIGATION .....	2-1
2.1 IHSS 115 (ORIGINAL LANDFILL) AND IHSS 196 (FILTER BACKWASH POND) .....	2-2
2.1.1 Stage 1 .....	2-2
2.1.2 Stage 2 .....	2-4
2.1.2.1 Geophysical Surveys .....	2-5
2.1.2.2 Soil Gas Survey .....	2-6
2.1.2.3 FIDLER Surveys .....	2-7
2.1.3 Stage 3 .....	2-8
2.1.3.1 Surface Soil Sampling .....	2-9
2.1.3.2 Characterization Borings .....	2-11
2.1.3.3 Investigation of Soil-Gas Anomalies .....	2-11
2.1.3.4 Surface-Water and Sediment Sampling .....	2-12
2.1.4 Stage 4 .....	2-13
2.1.4.1 Cone Penetrometer Testing .....	2-13
2.1.4.2 Well Points .....	2-14
2.1.4.3 Groundwater Investigation .....	2-16
2.1.5 Stage 5 .....	2-17
2.1.5.1 Investigation of Storm Sewer .....	2-18
2.1.6 Ambient Air Monitoring .....	2-18
2.2 IHSS 133 (ASH PITS, INCINERATOR, AND CONCRETE WASH PAD) .....	2-20
2.2.1 Stage 1 .....	2-20
2.2.2 Stage 2 .....	2-21
2.2.2.1 HPGe and FIDLER Surveys .....	2-21
2.2.2.2 Geophysical Surveys .....	2-22

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**  
**Section:**  
**Page:**  
**Organization:**

**21100-WP-OU05.1**  
**Table of Contents, Rev. 0**  
**ii**  
**ER OU 5, 6 & 7 Closures**

2.2.3	Stage 3 . . . . .	2-23
2.2.3.1	Surface Soil Sampling . . . . .	2-23
2.2.3.2	Soil Borings . . . . .	2-24
2.2.3.3	Investigation of Magnetic Anomaly . . . . .	2-26
2.2.4	Stage 4 . . . . .	2-26
2.2.4.1	Groundwater Investigation . . . . .	2-27
2.2.5	Ambient Air Monitoring . . . . .	2-29
2.3	IHSS 142.10 AND 142.11 (C PONDS) . . . . .	2-30
2.3.1	Stage 1 . . . . .	2-30
2.3.2	Stage 3 . . . . .	2-31
2.3.2.1	Surface-Water and Sediment Sampling . . . . .	2-31
2.3.2.2	Well Point Installation and Monitoring . . . . .	2-32
2.3.3	Stage 4 . . . . .	2-33
2.3.3.1	Groundwater Investigation . . . . .	2-33
2.4	IHSS 209 AND OTHER SURFACE DISTURBANCES . . . . .	2-35
2.4.1	Stage 1 . . . . .	2-35
2.4.2	Stage 2 . . . . .	2-36
2.4.2.1	Visual Inspection . . . . .	2-37
2.4.2.2	FIDLER Surveys . . . . .	2-38
2.4.3	Stage 3 . . . . .	2-39
2.4.3.1	Surface-Water and Sediment Sampling . . . . .	2-39
2.4.3.2	Surface Soil Sampling . . . . .	2-39
2.4.3.3	Soil Borings . . . . .	2-40
3.0	AMENDED PHASE I FIELD SAMPLING PLAN . . . . .	3-1
3.1	IHSS 115 (ORIGINAL LANDFILL) AND IHSS 196 (FILTER BACKWASH POND) . . . . .	3-1
3.1.1	Data Needs . . . . .	3-1
3.1.2	Field Sampling Plan . . . . .	3-3
3.1.2.1	Intrinsic Air Permeability Test Evaluation . . . . .	3-3
3.1.2.2	Geotechnical Evaluation . . . . .	3-4
3.1.2.3	Groundwater Investigation . . . . .	3-10
3.1.2.4	Storm Sewer Sampling . . . . .	3-12
3.1.2.5	Air Monitoring . . . . .	3-13
3.2	IHSS 133 (ASH PITS, INCINERATOR, AND CONCRETE-WASH PAD) . . . . .	3-19
3.2.1	Data Needs . . . . .	3-20
3.2.2	Field Sampling Plan . . . . .	3-21
3.2.2.1	Investigation of TDEM Anomalies . . . . .	3-21

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual:  
Section:  
Page:  
Organization:

21100-WP-OU05.1  
Table of Contents, Rev. 0  
iii  
ER OU 5, 6 & 7 Closures

---

3.2.2.2	Groundwater Investigation . . . . .	3-23
3.2.2.3	Air Monitoring . . . . .	3-25
3.3	IHSS 142.10 AND 142.11 (C PONDS) . . . . .	3-26
3.4	IHSS 209 AND OTHER SURFACE DISTURBANCES . . . . .	3-26
3.4.1	Data Needs . . . . .	3-26
3.4.2	Field Sampling Plan . . . . .	3-27
3.4.2.1	Surface Radiological Survey and Surface Soil Sampling . . . . .	3-27
4.0	REFERENCES . . . . .	4-1

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual:  
Section:  
Page:  
Organization:

21100-WP-OU05.1  
Table of Contents, Rev. 0  
iv  
ER OU 5, 6 & 7 Closures

---

## LIST OF TABLES

### Table No.

- |           |   |
|-----------|---|
| 3.1.2-1   | Summary of Amended Field Sampling Plan - IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond) |
| 3.1.2.3-1 | Analysis Parameters, Sequence of Collection, and Order of Priority for Groundwater Samples                |
| 3.2.2-1   | Summary of Amended Field Sampling Plan - IHSS 133 (Ash Pits, Incinerator, and Concrete-wash Pad)          |
| 3.4.2-1   | Summary of Amended Field Sampling Plan - IHSS 209 and Other Surface Disturbances                          |



---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual:  
Section:  
Page:  
Organization:

21100-WP-OU05.1  
Table of Contents, Rev. 0  
v  
ER OU 5, 6 & 7 Closures

---

## LIST OF FIGURES

### Figure No.

- |           |  |
|-----------|--|
| 1.2-1     | Woman Creek Priority Drainage Area (Operable Unit No. 5)                           |
| 2.1.-1    | IHSS 115, Original Landfill and Extended Areas, and IHSS 196, Filter Backwash Pond |
| 2.2-1     | Revised Locations of IHSS 133 Sites  |
| 2.2.2.2-1 | TDEM Survey Results, IHSS 133  |
| 2.4-1     | IHSS 209 and Surface Disturbance West of IHSS 209, Location Map                    |
| 2.4-2     | Surface Disturbance South of the Ash Pits, Location Map                            |
| 3.1.2.2-1 | Proposed Sampling Locations for IHSS 115   |
| 3.1.2.4-1 | Cowherd Wind Tunnel  |
| 3.1.2.4-2 | Emission Isolation Flux Chamber and Support Equipment                              |
| 3.2.2.1-1 | Proposed Borehole Location Map, IHSS 133 Series Area                               |
| 3.2.2.2-1 | Proposed Well Point and Monitoring Well Location Map, IHSS 133                     |
| 3.4.2.1-1 | Proposed HPGe Survey Locations, IHSS 209 and Surface Disturbance West of IHSS 209  |
| 3.4.2.1-2 | Proposed HPGe Survey, Surface Disturbance South of the Ash Pits                    |

## LIST OF ACRONYMS

1,1,1-TCA	1,1,1-trichloroethane
ACGIH	American Conference of Governmental Industrial Hygienists
ACM	asbestos-containing material
BAT®	Bengt-Arne Tortensson
BUTL	Background Upper Tolerance Limits
CDH	Colorado Department of Health
CMP	corrugated metal pipe
cpm	counts per minute
CPT	cone penetrometer testing
CSU	Colorado State University
DCN	Document Change Notice
DCM	dichloromethane
DOE	U.S. Department of Energy
EM	electromagnetic
EPA	U.S. Environmental Protection Agency
FIDLER	Field Instrument for the Detection of Low Energy Radiation
FSP	Field Sampling Plan
ft	feet
g	gram
H&S	health and safety
HPGe	high purity germanium
HSA	hollow-stem auger
IHSS	Individual Hazardous Substance Site
IHSS 115	Original Landfill
IHSS 133	Ash Pits, Incinerator, Concrete Wash Pad
IHSS 142.10	Pond C-1
IHSS 142.11	Pond C-2
IHSS 196	Water Treatment Plant Backwash Pond
IHSS 209	Surface Disturbances
kg	kilogram
m	meter
nCi/g	nanocuries per gram
OU	Operable Unit
OU5	Operable Unit No. 5
PAH	polynuclear aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**  
**Section:**  
**Page:**  
**Organization:**

**21100-WP-OU05.1**  
**Table of Contents, Rev. 0**  
**vii**  
**ER OU 5, 6 & 7 Closures**

---

pCi/g	picocuries per gram
PM <sub>10</sub>	inhalable particulate matter
PVC	polyvinyl chloride
QA	quality assurance
QC	quality control
RAAMP	Radioactive Ambient Air Monitoring Program
RCA	radiologically controlled area
RCRA	Resource Conservation and Recovery Act
RFEDS	Rocky Flats Environmental Data System
RFI/RI	RCRA Facility Investigation/Remedial Investigation
RFP	Rocky Flats Plant
s	seconds
SID	South Interceptor Ditch
SOPs	standard operating procedures
SVOC	semi-volatile organic compound
TAL	target analyte list
TCE	trichloroethene
TCL	toxic compound list
TDEM	time domain electromagnetic
TIC	tentatively identified compound
TM	Technical Memorandum
TOC	total organic carbon
UU	undrained unconsolidated
VOC	volatile organic compound

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 1.0, Rev. 0  
**Page:** 1-1  
**Organization:** ER OU 5, 6 & 7 Closures

---

## **1.0 INTRODUCTION**

This Technical Memorandum (TM) presents an amended Phase I Field Sampling Plan (FSP) Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) of the Woman Creek Drainage (Operable Unit No. 5 (OU5)) at the Rocky Flats Plant (RFP), Jefferson County, Colorado. This TM presents the results obtained during the implementation of the Phase I RFI/RI Work Plan for OU5 (DOE, 1992), identifies gaps in the data obtained thus far in the investigation and proposes an amended Phase I FSP for obtaining the information necessary to fill those gaps.

This TM is presented in two volumes. This volume, Volume 1, provides a summary of the data obtained by the Phase I RFI/RI to date (Section 2.0) and then provides a proposed amended FSP for obtaining necessary additional information (Section 3.0). Volume 2 of this TM presents a detailed discussion of the Phase I RFI/RI activities conducted to date. Volume 2 also outlines the methodology for and results of each stage of the investigation and provides the bases for the identification of data gaps and the development of the amended FSP.

### **1.1 PURPOSE OF PROJECT**

The purpose of the OU5 Phase I RFI/RI is to assess the potential contamination associated with several Individual Hazardous Substance Sites (IHSSs) that are located within the Woman Creek drainage. The data collected under the field investigation portion of the RFI/RI will be used to begin developing and screening remedial alternatives and to evaluate the need for further studies of the OU5 IHSSs. The data will also be used to estimate risks to human health and the environment posed by each IHSS.

This TM has two primary objectives. The first is to use the currently available results to describe the activities that have been performed under the Phase I RFI/RI. Volume 2 of this TM accomplishes the first objective. The second objective is to identify where additional data are required to assess the nature and extent of contamination at an IHSS and to provide an amended Phase I FSP for obtaining these data. This volume (Volume 1) of this TM addresses the second objective.

## 1.2 BACKGROUND

Eleven IHSSs, geographically located along or within the drainage areas of Woman Creek (Figure 1.2-1), have been designated as OU5. These IHSSs include the Original Landfill (IHSS 115); Ash Pits, Incinerator area, and Concrete Wash Pad (IHSSs 133.1 through 133.6); Detention Ponds C-1 and C-2 (IHSSs 142.10 and 142.11); and a Surface Disturbance (IHSS 209). Ponds C-1 and C-2 are the only IHSSs located on Woman Creek. The remaining IHSSs are located along the banks and/or upland areas that drain into Woman Creek or into the South Interceptor Ditch (SID). In addition to these IHSSs, two additional surface disturbances are being investigated in the Phase I OU5 investigation, a Surface Disturbance West of IHSS 209 and a Surface Disturbance South of the Ash Pits.

On May 27, 1993, the U.S. Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH) notified the U.S. Department of Energy (DOE) that IHSS 196, Filter Backwash Pond, was to be included in the OU5 investigation. This IHSS was previously scheduled to be investigated as part of Operable Unit 16 (OU16), Low Priority Sites. Because of its proximity to IHSS 115, the investigation of IHSS 196 was conducted concurrently with that of IHSS 115.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 1.0, Rev. 0  
**Page:** 1-3  
**Organization:** ER OU 5, 6 & 7 Closures

---

Section 1.2.1 of Volume 2 provides a detailed description of the physical setting and known disposal history of each of the OU5 IHSSs.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**  
**Section:**  
**Page:**  
**Organization:**

**21100-WP-OU05.1**  
**2.0, Rev. 0**  
**2-1**  
**ER OU 5, 6 & 7 Closures**

---

## **2.0 SUMMARY OF PHASE I FIELD INVESTIGATION**

This section provides a summary of the results obtained during implementation of the FSP defined by the OU5 Work Plan (DOE, 1992) and as amended by several TMs during various stages of the field investigation. A total of ten TMs were prepared during the implementation of the Phase I FSP at OU5. Section 2.1 of Volume 2 discusses the scope of the field investigation at each IHSS, as defined by the OU5 Work Plan and each of the TMs.

Sections 2.2 and 2.3 of Volume 2 describe the field investigation procedures and data analysis methodology, respectively, that were employed. All field investigations were conducted in accordance with the applicable RFP Standard Operating Procedures (SOPs). As discussed in Section 2.3 of Volume 2, the comparison of non-background data to background concentrations used for this TM consisted only of a comparison to background upper tolerance limits (BUTLs), as provided in the 1993 Background Geochemical Characterization Report (EG&G, 1993a). To date, background concentrations have not been established in the Background Geochemical Characterization Report for surface soils at RFP. However, several surface soil samples have been collected from the Rock Creek drainage northwest of RFP. The data for these soil samples are used as representative of background concentrations for surface soils in this TM.

As noted above, for the purposes of this TM the comparison of site data to background concentrations consisted only of a comparison to BUTLs. For those analytes where BUTLs were not provided by the Background Geochemical Characterization Report, the maximum background concentration for those analytes was used for this comparison. The BUTL for all organic compounds (volatiles, semi-volatiles, pesticides, and polychlorinated biphenyls (PCBs)) was considered to be the detection limit (i.e., any detected organic compound was considered to be present in concentrations exceeding background). The approach of using BUTLs is

believed to be adequate for providing an initial indication of the presence of contamination at an IHSS and for evaluating where additional data may be required to satisfy the objectives of the OU5 RFI/RI. This approach appears to be particularly valid for the purposes of this TM since the data that are absent for many IHSSs pertain to physical characteristics (e.g., the presence or absence of an ash pit) rather than chemical characteristics. When all of the samples collected under each stage of the Phase I RFI/RI have been analyzed, a larger suite of statistical tests (the Gilbert Methodology) will be applied to these data to select which site contaminants will be evaluated in the risk assessment process.

## **2.1 IHSS 115 (ORIGINAL LANDFILL) AND IHSS 196 (FILTER BACKWASH POND)**

Section 2.4 of Volume 2 provides a detailed discussion of the methodology for and results of the Phase I investigation conducted thus far at IHSSs 115 and 196. A summary of the information presented in Volume 2 is provided below. Figure 2.1-1 shows the locations of these IHSSs.

### **2.1.1 Stage 1**

Stage 1 activities conducted for IHSSs 115 and 196 included reviewing aerial photographs taken during the operation of the Original Landfill to identify the extent of disposal operations. Stage 1 also involved review of the results of a gamma radiation survey conducted in 1990 and a review of any additional studies conducted subsequent to completion of the OU5 Work Plan. These activities are discussed in detail in Section 2.4.1 of Volume 2.

The aerial photographs reviewed were vertical aerial photographs from the Aerial Photographic Analysis Comparison Report (EPA, 1988) and a series of oblique aerial photographs obtained



from the RFP archives. The review of available aerial photographs resulted in some modifications to the dimensions and boundaries of IHSS 115 shown in the OU5 Work Plan. These modifications are summarized below and shown on Figure 2.1-1.

- A suspect area shown as disturbed ground and a possible pit off the west end of IHSS 115 were identified.
- The surface disturbance east of the landfill was enlarged to include an area interpreted as rubble east of the road on the east side of the surface disturbance. This interpretation is based on an evaluation of oblique aerial photographs taken in December 1987 that clearly define the rubble piles. This rubble is interpreted as material used to construct a collection basin for the discharge outlet for the outfall pipe shown on Figure 2.1-1.
- The original outfall pipe, now abandoned, was constructed in 1986 and was extended to the south by a corrugated metal flume. The buried outfall pipe extending to the southeast was added in either 1987 or 1988. The construction of both storm-sewer pipes would have resulted in the displacement and reburial of a substantial amount of landfill material.
- The drainage ditch shown to the east of the outfall pipes was visible on vertical aerial photographs from 1955 through 1981 and was apparently covered or partially filled prior to 1983. The ditch is clearly visible on oblique photographs taken in 1967 and 1969 which show a culvert under the railroad tracks and probably under the main road. There is no photographic evidence that the culvert was removed, sealed, or extended before the ditch was covered.
- The berm shown to the south of the west end of the landfill was under construction in oblique photographs taken on November 15, 1967. Oblique photographs taken on June 5, 1969; July 11, 1969; and May 15, 1970 showed the area behind the berm (north side) in various stages of being filled with rubble and a number of large unidentifiable objects. It may be significant to note that one of the uranium-238 anomalies detected by the 1990 high purity germanium (HPGe) survey described below occurred just to the south of this berm.
- Oblique photographs showed that the pond identified on the 1955 vertical aerial photograph (IHSS 196) and interpreted to be filled in on subsequent photographs

appeared to have been completely washed out in later years. Consequently, any sludge or sediments that would have accumulated when the pond was in use may have spread out below the pond site or been deposited in Woman Creek prior to the construction of the South Interceptor Ditch (SID).

- Aerial photographs indicated that the landfill was operated as an area fill. Waste appeared to have been dumped over the southern edge of the alluvial pediment on which RFP is located and spread over the southerly-facing slopes incised by Woman Creek. Groundtruthing, conducted as part of the aerial photograph review process, indicated that the landfill cover is intact above a topographic break near the center of the landfill, which signifies the upper edge of a slump. Below the topographic break, the cover appears to be eroded with numerous small slumps, which locally expose some of the waste.

During the period from October 25, 1990 through December 8, 1990, a gamma radiation survey was conducted over the area of the Original Landfill using a 20 percent N-type, HPGe detector (DOE, 1992). The survey data are presented in Volume II, Appendix B, of the OU5 Work Plan. This investigation found that radiation in the soil was contributed from potassium, uranium, and thorium. Radium and cesium were also measured indirectly from daughter isotopes. Review of these data indicates that activity from most of the detected isotopes was consistent with natural background; however, there were areas that exhibited elevated uranium-238 activity (hot spots). The uranium-238 hot spots identified by this review were surveyed and marked with stakes for subsequent radiological surveys (Section 2.1.2) and sampling activities (Section 2.1.3).

#### **2.1.2 Stage 2**

Stage 2 activities at IHSS 115/196 consisted of geophysical and soil gas surveys, as were specified in the OU5 Work Plan. In addition, a radiological survey with a Field Instrument for the Detection of Low Energy Radiation (FIDLER) was conducted to supplement the 1990 HPGe

survey discussed in the previous section. Section 2.4.2 of Volume 2 discusses the Stage 2 activities in detail, and they are summarized in this section.

#### 2.1.2.1 Geophysical Surveys

Frequency-domain electromagnetic (EM) and magnetometer geophysical surveys were conducted in IHSS 115/196 from October through December 1992. The magnetometer survey conducted at IHSS 115/196 was evaluated for indications and locations of buried ferromagnetic objects. Such objects may be an indication of buried waste, thereby indicating possible IHSS boundaries. The EM survey conducted helped to characterize the landfill boundaries by conductivity differences between native and disturbed soil. The results of these surveys confirmed the known location of the landfill and did not identify additional areas requiring investigation.

The magnetic data (Figure 2.4.2.1-1 in Volume 2) indicate an anomalous area that coincides with the known location of the landfill. This presumably is associated with buried metallic objects in the landfill. Useful data could not be acquired beneath the power lines near the southern boundary of the landfill due to the overriding EM interference produced by the lines.

The EM conductivity data (Figure 2.4.2.1-2 in Volume 2) exhibit an anomalous area of relatively high conductivity that coincides to the known location of the Original Landfill. This anomalous area may be attributed to the higher moisture content of disturbed ground, an extensive amount of landfill cover material or disturbed sediments, differences in geological sediments, or buried conductive metallic objects. A large anomaly that occurs in the main portion of the landfill correlates with the area in which the most intensive magnetic anomalies occur and may be attributed in part to buried metallic objects.

#### 2.1.2.2 Soil Gas Survey

A real-time soil gas survey was performed at IHSS 115/196 as proposed by the OU5 Work Plan. The purpose of the soil gas survey was to provide Phase I screening-level data concerning the presence or absence of volatile organic contaminants at the Original Landfill, including IHSS 196, and the disturbed area east of the Original Landfill (DOE, 1992). Volatile organic compounds (VOCs) that may have been placed in the landfill include commonly-used solvents, such as trichloroethene (TCE), carbon tetrachloride, tetrachloroethene (PCE), petroleum distillates, 1,1,1-trichloroethane (1,1,1-TCA), dichloromethane (DCM), benzene, paint, and paint thinners (DOE, 1992). The survey involved the collection and analysis of over 300 soil gas samples.

Anomalous readings encountered during the survey were further investigated by additional soil gas sampling. Plumes of VOCs identified by the soil gas survey were further assessed by the subsequent drilling of boreholes within the plumes and installation of groundwater monitoring wells downgradient of the plumes (Section 2.1.3.3). The results of the soil gas survey are discussed in detail in Section 2.4.2.2 of Volume 2.

The survey resulted in the identification of three areas of anomalous concentrations of 1,1,1-TCA, TCE, and PCE. One of these areas was located near the center of the landfill adjacent to the abandoned storm-sewer outfall (Figure 2.1-1). The other two areas were located on a hillside adjacent to IHSS 196 (Figure 2.1-1).

In July 1993 (subsequent to completion of the soil gas survey), a small-scale intrinsic air permeability study was conducted in, and adjacent to, IHSS 115. The purpose of the study was to assess the intrinsic air permeability of the OU5 area with more precision than the general

order-of-magnitude estimates provided in charts of permeability versus soil type. Preliminary examination of the results of this study indicate that short circuiting could have occurred during the performance of the soil gas survey. Short circuiting is the drawing of fresh air through the subsurface formation from a point near the vapor extraction well instead of drawing the subsurface vapors that are further from the well. The subsurface vapor is then diluted by the fresh air, and consequently, the vapor concentration observed in the laboratory is less than the actual subsurface concentration. As discussed in Section 3.1, the results of the intrinsic air permeability study require further evaluation to determine whether short circuiting occurred.

#### 2.1.2.3 FIDLER Surveys

Several areas of IHSS 115 were surveyed with a FIDLER during March to June 1993. The purpose of this survey was to further delineate anomalies identified by the 1990 HPGe survey discussed in Section 2.1.2.1. The HPGe survey of the IHSS 115 area conducted in 1990 identified ten areas of anomalous uranium-238 activity. Due to the nature of the HPGe survey (i.e., it detects radiation over a relatively large area), it was necessary to perform an additional surface radiological survey to identify the source(s) of these anomalies. The results of this survey would provide information necessary to direct surface soil sampling activities (Section 2.1.3.1) and to identify where it may be necessary to establish Radiologically Controlled Areas (RCAs) to control personnel movement within those areas. Section 2.4.2.3 of Volume 2 details the performance and results of this survey.

At two HPGe stations located near the center of the landfill, the FIDLER surveys identified nine areas of anomalous radioactivity. Each of these areas was posted as a RCA. The source of radiation in several of these areas was determined to be from material that is protruding from the landfill surface. The remaining areas do not contain specific sources of radiation but appear

to encompass areas of contaminated soil or contain small particles of radioactive material scattered over a relatively large area. As discussed in Section 2.1.3.1, in those areas where a piece of landfilled material was not identified as the source of the detected radiation, surface soil samples were collected to characterize the contamination present.

Several pieces of radioactive material were removed from these areas on May 28, 1993 during an emergency removal action. This material was placed in an area designated for the storage of radioactive material. The material removed consisted of a 4- to 6-inch diameter piece of concrete coated with a corroded metallic material and several small (1- to 2-inch diameter) spherical pieces of rusty material. Measurements performed by EG&G Radiological Engineering indicated that the principle isotope present in these materials was uranium-238, although no quantification of the activity present was provided. During the collection of surface soils (Section 2.1.3.1), several other pieces of radioactive material were removed from these areas. One was a rod-shaped material similar to the larger piece described above. Analyses conducted by Radiological Engineering determined that this rod contained approximately 25 nanocuries per gram (nCi/g) of uranium-238. The analyses of all of the materials removed indicated that the uranium was depleted.

### 2.1.3 Stage 3

Stage 3 activities at IHSS 115/196 consisted of the collection of surface soil samples, the drilling and sampling of characterization boreholes, and further investigation of the anomalies detected by the soil gas survey discussed in Section 2.1.2.2. Stage 3 activities are discussed in detail in Section 2.4.3 of Volume 2 and are summarized in this section.

#### 2.1.3.1 Surface Soil Sampling

The surface soil sampling at IHSS 115/196 was conducted in two phases (see Section 2.4.3.1 of Volume 2). The Phase 1 program collected surface soil samples from an area defined by Stage 1 review of aerial photographs and by review of the 1990 HPGe radiation survey data for IHSS 115/196 (Section 2.1.1). Phase 2 surface soil sampling would have been implemented if the Stage 2 field investigations, discussed in Section 2.1.2, indicated that the areal extent of the landfill was greater than the aerial photos and the 1990 HPGe radiation survey indicated. None of the Stage 2 activities indicated that the extent of the landfill was larger than previously known, and only the Phase 1 sampling program was conducted.

The Phase 1 sampling program was designed to include ten biased samples from the radiation anomalies identified by the HPGe survey and 51 random samples collected on a grid. The sampling plan also provided for additional surface soil samples to be collected from suspected contaminated areas identified by other ongoing investigations of IHSS 115/196. FIDLER surveys were among the ongoing investigations and were used to pinpoint the location of the anomalies identified during the 1990 HPGe radiation survey (Section 2.1.2.3). As a result of the FIDLER surveys, two additional surface soil samples were collected.

Surface soil samples were collected at 66 locations in IHSS 115/196. Fifty four of the samples were analyzed for target analyte list (TAL) metals, radionuclides, pesticides, PCBs, semi-volatile organic compounds (SVOCs), bulk density, particle size, specific conductivity, carbonate, pH and total organic carbon (TOC). Twelve of the samples were collected at HPGe and/or FIDLER anomalies and were analyzed only for radiological parameters. Two sediment samples were also collected from seeps near IHSS 115 and were analyzed for radionuclides, TAL metals, pesticides, PCBs, SVOCs, and VOCs.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**  
**Section:**  
**Page:**  
**Organization:**

**21100-WP-OU05.1**  
**2.0, Rev. 0**  
**2-10**  
**ER OU 5, 6 & 7 Closures**

---

The analyses of surface soil samples identified samples with concentrations of copper (13 samples), zinc (five samples), silver (two samples), and lead (one sample) greater than background. Results for five of the 12 surface soil samples collected from HPGe anomalies have been reported by the laboratories, and all five exhibited radioactivity exceeding BUTLs. Uranium-233/234, uranium-235, and uranium-238 exceeded the BUTLs in all five samples, plutonium-239/240 exceeded the BUTL in two of the samples, and americium-241 exceeded the BUTL in one sample. The analytical results for the remaining seven samples collected from radiation anomalies have not been received, but all of these samples displayed anomalous levels of radiation on field instruments. Some of these samples were also analyzed by EG&G Radiological Engineering using a portable HPGe detector. These analyses indicated that uranium-238 is the principal radionuclide present.

Uranium-233/234 (three samples), uranium-235 (one sample), uranium-238 (eight samples), plutonium-239/240 (two samples), and americium-241 (one sample) were detected at activities exceeding background in the samples collected at the 54 random locations. Pesticides, PCBs, and a wide variety of SVOCs were also detected in several surface soil samples. The locations where the concentrations of both inorganic and organic compounds exceeding background concentrations were detected are centered around the abandoned storm-sewer outfall near the center of the landfill (Figure 2.1-1).

One sediment sample collected from seeps adjacent to IHSS 115 exhibited an antimony concentration greater than the BUTL. Neither of the two sediment samples from the IHSS 115 area contained radionuclides with activity greater than the BUTL nor detectable concentrations of pesticides and PCBs. Both of these samples contained detectable quantities of SVOCs, and one sample contained a detectable concentration of PCE.



#### 2.1.3.2 Characterization Borings

Eight boreholes were installed in IHSS 115/196 for subsurface characterization purposes as part of the OU5 Phase I RFI/RI. Six boreholes were installed in the disturbed area east of the landfill (Figure 2.1-1), and the remaining two were located in the former ponds (IHSS 196). The characterization boring program is discussed in detail in Section 2.4.3.2 of Volume 2.

Metals analyses resulted in the detection of five constituents (barium, copper, lead, manganese, and zinc) at concentrations exceeding BUTLs in samples from three of the eight boreholes. Radiological analyses identified several samples from three of the eight boreholes with activities of plutonium-239/240, americium-241, and uranium-238 greater than BUTLs. All of the radiological contamination indicated for these locations appears to be confined to samples collected from the upper 6 feet (ft) of each borehole. The laboratory analyses performed on the soil samples collected from IHSS 196 resulted in the detection of several pesticides and PCBs. However, neither pesticides nor PCBs were detected in samples from boreholes in the disturbed area east of the landfill. A variety of SVOCs and VOCs were detected in samples from boreholes at both locations.

#### 2.1.3.3 Investigation of Soil-Gas Anomalies

Four boreholes and two "mini-wells" were installed within the anomalies identified by the soil-gas survey (Section 2.1.2.2) to further investigate these anomalies. The four boreholes were installed within the anomalies located adjacent to IHSS 196. Soil samples were collected during drilling from these boreholes, and a one-time groundwater sample was collected with a Hydropunch II sampling device from one borehole. The mini-wells (small-diameter monitoring wells) were installed within the anomaly near the center of the landfill. Due to the

inaccessibility of this area to a large drill rig, these mini-wells were installed using a small hydraulic rig mounted on an all-terrain vehicle. Soil samples were collected at these locations during drilling, and a groundwater sample was collected from one of the mini-wells (the other mini-well was dry). The installation, sampling, and results for these boreholes and mini-wells are discussed in Section 2.4.3.3 of Volume 2.

The results of the analyses of the soil and groundwater samples collected from the boreholes and mini-wells drilled within each soil-gas anomaly confirmed the results of the soil-gas survey. The VOCs detected by the soil-gas survey were also detected in soil and groundwater samples at each anomaly. In addition, several metals, plutonium-239/240, americium-241, uranium-233/234, uranium-235, uranium-238, pesticides, PCBs, and SVOCs were detected at concentrations exceeding background levels at several locations.

#### **2.1.3.4 Surface-Water and Sediment Sampling**

The Phase I FSP outlined by the OU5 Work Plan specified the collection of surface-water and sediment samples from throughout the Woman Creek drainage. Although the OU5 Work Plan called for this sampling program under Stage 3 of the IHSS 115 investigation, the samples collected were to provide data applicable to the other OU5 IHSSs. TM1 (EG&G, 1993b, as amended) was prepared to summarize existing data collected under other programs and to define a revised surface-water and sediment sampling program for OU5. The results obtained by this sampling program are detailed in Section 2.4.3.4 of Volume 2.

Surface-water samples were collected from various locations in the Woman Creek drainage during two base-flow sampling events (November 1992 and March 1993) and two high-flow sampling events (March 1993 and May 1993). An additional high-flow sampling event took

place during April 1994, and no results are available yet for this event. Analyses of the data from the two base-flow and first high-flow sampling events indicate that a few samples contained greater than background concentrations of some analytes.

Sediment samples were collected one time at various locations in the Woman Creek drainage. Several constituents were detected at concentrations exceeding background at various locations.

#### **2.1.4 Stage 4**

Stage 4 activities conducted at IHSS 115/196 consisted of a cone penetrometer testing (CPT) program and the investigation of groundwater quality through the use of well points and monitoring wells. The implementation and results of these activities are discussed in detail in Section 2.4.4 of Volume 2 and are summarized in this section.

##### **2.1.4.1 Cone Penetrometer Testing**

Performance of CPT was proposed in the OU5 Work Plan as part of Stage 4 activities of the Phase I RFI/RI of IHSS 115. The OU5 Work Plan also specified that a TM be prepared outlining the details of the cone penetrometer use, type of sampler, and spacing of test locations. TM6 (EG&G 1993c) was prepared based upon evaluation of work conducted during Stages 1, 2, and 3 and provides specifics of the proposed CPT program. Section 2.4.4.1 of Volume 2 discusses the CPT program in detail.

CPT provides a way to rapidly measure soil parameters such as tip resistance, local friction, and pore pressure. The overall purpose of the CPT sampling program as stated in both the OU5 Work Plan and TM6 was to:

- characterize subsurface sediment type (lithology),
- interpolate subsurface conditions between control boreholes,
- locate the possible occurrence of saturated soils,
- assist in selecting locations for groundwater samples,
- assist in selecting locations for monitoring wells, and
- to a lesser degree for this investigation, evaluate soil parameters (i.e., shear strength, etc...).

As specified in TM6, CPT was performed during April 1993 along a single line of locations near the "toe" of the Original Landfill and south of the SID with a maximum of 100 ft between locations.

Five significant bedrock lows were identified by the CPT program. Water was found to be present in three of the bedrock lows; the other two locations were dry. Water was also found at two areas identified as bedrock highs. The information provided by CPT was used to subsequently locate well points (Section 2.1.4.2) and monitoring wells (Section 2.1.4.3) to investigate groundwater quality in the vicinity of the landfill.

#### 2.1.4.2 Well Points

Performance of one-time groundwater sampling associated with the CPT program was proposed in the OU5 Work Plan as part of Stage 4 of the Phase I RFI/RI of IHSS 115. TM6 (EG&G 1993c) specified locations for groundwater samples and analyte lists. The OU5 Work Plan stated that groundwater be sampled with a Bengt-Arne Tortensson (BAT®) (or equivalent) sampling device. TM6 specified that the groundwater samples be obtained using well points

rather than the BAT<sup>®</sup> because of advantages related to sampling intervals (i.e., screened length) and sample volumes (EG&G, 1993c). The installation and sampling of these well points is discussed in Section 2.4.4.2 of Volume 2.

A total of 10 well points were installed along the downgradient perimeter of IHSS 115. Well points that produced a sufficient amount of groundwater were sampled one time shortly after installation. At the time these well points were sampled, two well points located near IHSS 115 that were installed as part of an EG&G study of seeps and springs, and one of the mini-wells installed within one of the soil gas anomalies were also sampled.

The following is a list of constituents detected in samples of groundwater from within the footprint of the landfill at concentrations greater than BUTLs (all results are for unfiltered samples):

- lithium, nickel, and strontium;
- common anions of calcium, magnesium, and manganese;
- radium-226 and strontium-89/90;
- general water quality parameters of orthophosphate and TDS; and
- VOCs of acetone, 1,1-DCE, 1,2-DCE, 1,1,1-TCA, TCE, and PCE.

The well points indicated the presence of groundwater near the toe of the Original Landfill. Potential migration pathways have been characterized as locations that have groundwater present. However, given that where samples could be obtained and where constituents were detected

exceeding BUTLs, the chemistry of groundwater downgradient of the landfill needs further investigation (Section 3.1.2.3).

#### 2.1.4.3 Groundwater Investigation

According to the OU5 Work Plan (DOE, 1992), seven monitoring wells were to be installed at IHSS 115 as part of the OU5 Phase I RFI/RI. The OU5 Work Plan also stipulated that the exact location, type, and number of monitoring wells would depend on the results of Stages 1 through 3 of the Phase I investigation, and that this information would be presented in a TM. A letter dated June 18, 1993 replaced this proposed TM (see Appendix A of Volume 2). This letter proposed that five wells be installed downgradient of the landfill and one installed within IHSS 196. The purpose of these wells was to monitor present and future contaminant levels downgradient of the landfill and to help establish future or present contaminant migration problems. The details of the groundwater investigation are provided in Section 2.4.4.3 of Volume 2.

Five monitoring wells and two boreholes were installed as part of the groundwater investigation of IHSS 115/196. The two boreholes were drilled at locations originally intended for monitoring wells but where groundwater was not encountered during drilling. The boreholes were plugged and abandoned, and alternate locations were selected for installation of monitoring wells. Soil samples were collected during the drilling of all wells and boreholes, and the two wells that produce sufficient groundwater are being sampled on a quarterly basis.

Copper, chromium, nickel, silver, zinc, and manganese were detected in concentrations exceeding BUTLs in soil samples collected from these wells and boreholes. Plutonium-239/240 was also detected in two soil samples at activities exceeding the BUTL. The PCB Aroclor-1254

was detected in a soil sample from the well installed within IHSS 196. A variety of SVOCs and VOCs were also detected in several soil samples from these wells and boreholes.

Groundwater samples collected from these wells have contained a large number of metals at concentrations exceeding BUTLs. Plutonium-239/240, americium-241 and radium-226 have also been detected at activities exceeding background. No pesticides or PCB constituents were detected in the groundwater samples collected to date in the IHSS 115/196 monitoring wells. A variety of SVOCs have been detected in groundwater samples, primarily those from the well installed within IHSS 196, and the VOC methylene chloride, a common laboratory contaminant, was also detected in one sample from the well within IHSS 196.

Two of the wells installed at IHSS 115/196 were selected for aquifer testing. A multiple-well pumping test was performed at IHSS 196, and a single-well slug test was performed in one well downgradient of IHSS 115. The multiple well test appears to have been successful; however, the slug test data indicated that the results at that location may not be representative of the formation's characteristics but may represent the hydraulic conductivity of the filter pack (see Section 2.4.4.3 of Volume 2).

#### **2.1.5 Stage 5**

Stage 5 activities at IHSS 115 involved investigation of the storm-sewer pipelines that protrude from the Original Landfill area. These activities are discussed in detail in Section 2.4.5 of Volume 2 and are summarized in this section.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**  
**Section:**  
**Page:**  
**Organization:**

**21100-WP-OU05.1**  
**2.0, Rev. 0**  
**2-18**  
**ER OU 5, 6 & 7 Closures**

---

#### **2.1.5.1 Investigation of Storm Sewer**

The activities performed to investigate the storm-sewer pipelines included collecting a one-time sample of the water discharging from the active pipeline and performing a video-camera survey of the storm-sewer system to determine and/or verify connections and the source of the constant discharge from the system.

Analytical results of the single sample obtained during dry weather from the storm-sewer outfall did not indicate elevated concentrations for radionuclides, trace metals, or priority pollutants (organic constituents).

The video-camera survey of the pipeline indicated that, for the most part, the storm-sewer system had only small rocks and sediment along its invert, some slight groundwater inflows at joints and manholes, and an occasional 6-inch polyvinyl chloride (PVC) roof drain connection entering through the top portion of the pipe. However, a continuous dry-weather discharge was seen entering the system through a 12-inch corrugated metal pipe (CMP) at a manhole from the Building 447 foundation underdrain system (Jacobs, 1994). Another manhole had an intermittent high-velocity inflow which entered the manhole through a 6-inch PVC pipe located at the southeast corner of the manhole. This inflow appeared to be pumped into the manhole from a sump pump. Based on the location of the pipe, the flow is assumed to be coming from Building 440 or the evaporative cooling tower located along the west side of Building 440.

#### **2.1.6 Ambient Air Monitoring**

Ambient air monitoring was conducted to investigate the primary release mechanism of fugitive dust wind erosion of radiologically-contaminated surface soils from IHSS 115/196 in OU5.



---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:**

**21100-WP-OU05.1**

**Section:**

**2.0, Rev. 0**

**Page:**

**2-19**

**Organization:**

**ER OU 5, 6 & 7 Closures**

---

Health and safety (H&S) monitoring for personnel protection provided some additional information about the potential release mechanisms of volatilization of organic gases and of airborne transport of radiological contaminants and hazardous materials from surface and subsurface soils.

Data from the monitoring network known as the Radioactive Ambient Air Monitoring Program (RAAMP) and from three samplers installed specifically to monitor ambient radionuclide levels around OU5 were analyzed to determine whether airborne releases are significant from IHSS 115/196. Information collected by H&S personnel during the implementation of field investigations was also reviewed. This analysis concluded that the presence of multiple sources throughout the facility and the placement of the RAAMP samplers limits the specific applicability of RAAMP data to OU5.

Examination of the special OU5 sampler data indicates that the uranium-233/234 and uranium-235 results are within the same order of magnitude for both the sampler downwind of IHSS 115/196 and the sampler upwind of OU5. These preliminary data seem to indicate no discernible contributions to ambient concentrations of either uranium-233/234 or uranium-235 from IHSS 115/196. The americium-241, plutonium-239/240, and uranium-238 average concentrations for the downwind sampler are one order of magnitude greater than the average concentrations of the upwind sampler. Contributions to ambient concentrations of americium-241, plutonium-239/240, or uranium-238 by IHSS 115/196 appear possible. In all cases, for all data, conclusions about possible radionuclide emissions from IHSS 115/196 can only be made after complete statistical analysis of validated data.

Results of the H&S monitoring that was done during the field investigations of IHSS 115/196 provide a qualitative indication of potential air pathway risks attributable to this source.

Elevated organic vapor readings were observed during investigations at two borehole locations during drilling operations. During field investigation of two HPGe anomalies near the center of the landfill, beta-gamma monitoring registered 60,000 counts per minute (cpm) on one occasion and 10,000-80,000 cpm on another.

## **2.2 IHSS 133 (ASH PITS, INCINERATOR, AND CONCRETE WASH PAD)**

Section 2.5 of Volume 2 provides a detailed discussion of the methodology for and results of the Phase I investigation conducted thus far at the IHSS 133 group. A summary of the information presented in Volume 2 is provided below. Figure 2.2-1 shows the locations of these IHSSs.

### **2.2.1 Stage 1**

Stage 1 activities at the 133-series IHSSs consisted of a review of historical aerial photographs to determine the extent of each disposal area. The results of this review are discussed in detail in Section 2.5.1 of Volume 2.

The location of IHSS 133.3 as shown on Figure 2-6 of the OU5 Work Plan appears to be incorrect. The review of aerial photographs does not support the existence of a trench in the location shown in the OU5 Work Plan. These photographs indicated that IHSS 133.3 is located south of the location shown in the OU5 Work Plan (Figure 2.2-1). During the course of this investigation, it was also determined that the location of IHSS 133.1, as shown on Figure 2-6 in the OU5 Work Plan, and in the first several TMs was erroneous. IHSS 133.1 was previously shown east of the Incinerator and north of the ash pits (Figure 2.2-1). As shown on Figure 2.2-1, IHSS 133.1 is actually the northernmost trench, previously identified as belonging to IHSS 133.3.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 2.0, Rev. 0  
**Page:** 2-21  
**Organization:** ER OU 5, 6 & 7 Closures

---

Photographs recently obtained from several aerial photograph companies that cover the years that were absent in the photographs previously available confirm the presence of at least two additional pits not previously identified (Section 2.2.2.2).

## **2.2.2 Stage 2**

Stage 2 activities at the IHSS 133 sites included surface radiological and geophysical surveys, as were specified by the OU5 Work Plan. These activities are discussed in detail in Section 2.5.2 of Volume 2 and are summarized in this section.

### **2.2.2.1 HPGe and FIDLER Surveys**

A radiation survey of the IHSS 133 area was initiated in the summer of 1992 using tripod-mounted, HPGe gamma-ray detector instruments. This initial survey did not cover the entire IHSS 133 area and was followed by a second truck-mounted HPGe survey configured to count activity over a larger area and to provide full coverage for each of the IHSS 133 sites. In addition to the HPGe surveys, a FIDLER was used as an aid in focusing sampling investigations within anomalies identified by the HPGe surveys.

The 1992 tripod-mounted HPGe survey identified two areas of anomalous uranium-238 activity. One of these areas also displayed an elevated uranium-235 activity. The 1993 truck-mounted survey corroborated the anomalous activity detected by the 1992 survey at one location but not the other. Both locations were subsequently surveyed with a FIDLER. At the location identified by both HPGe surveys, an area approximately 35 ft wide and 76 ft long containing surface contamination was identified and cordoned off as a RCA. The area is located immediately to the south and downslope of a small mound and depression in the topography. No historical

information regarding the origin of the mound and depression was found during investigation of this area, however, a borehole drilled within the mound encountered waste material (Section 2.2.3.2).

The anomaly associated with the 1992 tripod-mounted HPGe survey that was not identified by the 1993 truck-mounted survey was also not confirmed by the FIDLER survey. However, the FIDLER survey identified one anomalous area in the vicinity of this location that appeared to be associated with a pile of contaminated scrap metal.

#### 2.2.2.2 Geophysical Surveys

Frequency-domain EM and magnetometer geophysical surveys were conducted in IHSS 133 from October through December 1992. In addition, a time-domain electromagnetic (TDEM) survey was conducted in IHSS 133 from January through February 1994. This TDEM survey was performed with a Geonics EM61 instrument, a new instrument that was not available at the time the other geophysical surveys were performed. The results of these surveys are discussed in detail in Section 2.5.2.2 of Volume 2.

Although the frequency-domain EM and magnetometer surveys indicated several anomalies that appear to be related to known ash pits, the success of these surveys in confirming the locations of the known ash pits or identifying unknown disposal sites was limited. The TDEM survey produced excellent results (Figure 2.2.2.2-1). This survey confirmed the locations of several pits previously identified by the review of aerial photographs. It also corroborated the results of the borehole program (Section 2.2.3.2) in that boreholes drilled into areas subsequently identified as anomalous by the TDEM survey did encounter waste material while those boreholes that did not encounter waste were located in areas where TDEM anomalies were absent. The

TDEM survey also identified several additional anomalous areas that require further investigation (Section 3.2.2.1).

### **2.2.3 Stage 3**

Stage 3 activities at the IHSS 133 sites included the collection of surface and subsurface soil samples in and around each IHSS. In addition, subsurface soil samples were collected from within an anomaly identified by the magnetic survey of the area. These activities are discussed in detail in Section 2.5.3 of Volume 2 and are summarized in this section.

#### **2.2.3.1 Surface Soil Sampling**

The scope of work for the Stage 3 surface soil sampling program is described in TM4 (EG&G 1993d). Two phases of surface soil sampling were proposed in TM4. The first phase of the proposed sampling program was to identify elevated concentrations of metals and polynuclear aromatic hydrocarbons (PAHs), and to confirm the results of the initial HPGe survey for radionuclides in surface soils within the IHSS 133 area. The second phase of sampling was proposed to assess areas of elevated radioactivity that were identified after a second radiation survey of IHSS 133 was completed. The surface soil sampling program is discussed in Section 2.5.3.1 of Volume 2.

A total of 20 surface soil samples were collected at 20 locations in IHSS 133. Eighteen of the samples were analyzed for TOC, TAL metals, PAHs, and radiological parameters. The two profile samples were collected at HPGe stations and were analyzed only for radiological parameters. These profile samples are to be used to assist in evaluating the HPGe program.

Two sediment samples from seeps were collected and analyzed for radionuclides, TAL metals, pesticides, PCBs, SVOCs, and VOCs.

BUTLs were exceeded in one surface soil sample for zinc and one for silver. Data for samples collected at the two HPGe stations were not available in RFEDS as of January 28, 1994. Gross alpha, uranium-233/234, and uranium-238 were detected in concentrations exceeding BUTLs in one, seven, and 14 surface soil samples, respectively. None of the surface soil samples contained detectable concentrations of PAHs.

Both seep sediment samples from IHSS 133 exhibited zinc exceeding the BUTL and antimony exceeded the BUTL in one of these samples. One of the sediment samples contained uranium-238 exceeding the BUTL. The SVOC bis(2-ethylhexyl)phthalate was detected in one of the sediment samples. Sediment samples did not contain detectable concentrations of PAHs or VOCs.

#### 2.2.3.2 Soil Borings

The OU5 Work Plan (DOE, 1992) proposed placing boreholes on 25-foot centers that transect each IHSS in order to delineate the boundaries of the Ash Pits. The FSP also stipulated that if the boundaries of IHSS 133 could be determined by aerial photography review, radiological survey, and/or the proposed geophysical surveys, fewer boreholes would be necessary. The aerial photograph review and geophysical survey results were partially successful at delineating these boundaries and were presented in TM7 (EG&G, 1993e). Based on the results of the aerial photograph review and geophysical survey results, TM7 proposed a soil-borehole program that included drilling 28 boreholes and an undesignated number of shallow offset boreholes to be used in locating the Ash Pit(s). TM7 also proposed placing a borehole in the central location

of any anomalous areas detected by the HPGe survey. Section 2.5.3.2 of Volume 2 discusses the drilling, sampling, and results for the borehole program.

The completed soil-boring program included the installation of 53 boreholes. Two of these boreholes were placed in the mound north of a hot spot that was detected during the HPGe survey (Section 2.2.2.2). Six of the boreholes drilled in this IHSS were originally intended to be wells as part of the groundwater investigation; however, no groundwater was encountered during drilling and the wells were abandoned and reclassified as boreholes (Section 2.2.4.1). Seventeen boreholes were 10- to 12-foot deep offsets. The remaining 28 boreholes were drilled in the locations specified in TM7. Soil samples were collected from all of the boreholes except the offsets, and four one-time groundwater samples were collected with a Hydropunch II sampling device during drilling.

As detailed in Section 2.5.3.2 of Volume 2, the borehole program was moderately successful in confirming the presence of the ash pits. As discussed in Section 2.2.2.2, the TDEM survey that was performed subsequent to the borehole program demonstrated that boreholes that did not encounter waste in pits identified on aerial photographs were not mislocated but possibly were drilled into pits that were excavated but never used.

Soil and groundwater samples from boreholes that encountered waste material typically contain concentrations of metals and radionuclides that exceed background concentrations. Samples from boreholes that did not encounter waste generally contain background levels of most constituents.

#### **2.2.3.3 Investigation of Magnetic Anomaly**

Results from the magnetic survey conducted in Stage 2 of the Phase I investigation indicated an anomaly on the west side of the IHSS 133 area (see Figure 2.5.3.3-1 in Volume 2). Since the dimensions of this anomaly were similar to the Ash Pits, it was necessary to investigate this anomaly in the event that an unknown Ash Pit was at this location. This anomaly was investigated by drilling three boreholes along the long axis of the anomaly. The results of this investigation are detailed in Section 2.5.3.3 of Volume 2.

No ash, waste material, or groundwater were encountered in these boreholes. The alluvial material encountered appeared to be undisturbed Rocky Flats Alluvium. The analysis of soil samples collected from these boreholes indicated one barium result, one nickel result, and two plutonium-239/240 results greater than BUTLs. Although exceeding the BUTL, the two plutonium-239/240 results were within the range of concentrations reported for background Rocky Flats Alluvium. No other constituents were present at concentrations exceeding background concentrations in samples from these boreholes.

The results of the drilling program do not indicate the presence of an ash pit or other disposal unit in this area. This conclusion is further supported by the results of the TDEM survey which do not indicate the presence of any buried waste material in this area.

#### **2.2.4 Stage 4**

Stage 4 activities at the IHSS 133 sites consisted of the installation and sampling of groundwater monitoring wells and aquifer testing. The implementation and results of these activities are discussed in Section 2.5.4 of Volume 2 and are summarized in this section.



#### 2.2.4.1 Groundwater Investigation

According to the OU5 Work Plan (DOE, 1992), three monitoring wells were to be installed in IHSS 133 as part of the OU5 Phase I RFI/RI. The OU5 Work Plan stipulated that the exact location, type, and number of monitoring wells would depend on the results of the preliminary Phase I investigations and that this information would be presented to EPA and CDH in a TM. TM9 was prepared and issued to the agencies on June 18, 1993 (EG&G, 1993f). This TM proposed four wells to be installed downgradient of the IHSS 133 sites (see Figure 2.5.4.1-1 in Volume 2). The purpose of these wells was to monitor future and present contaminant levels downgradient of IHSS 133 and to help establish future or present contaminant migration problems.

The proposed monitoring well locations presented in TM9 were selected based on the results of the aerial photograph review, the HPGe survey, the geophysical surveys (excluding the results of the TDEM survey which had not yet been performed), the borehole program, well point water-level data, and field reconnaissance. Three cross sections were developed from field logs of previously installed boreholes to assess potential groundwater flow paths. Flow paths of particular interest were those originating from, or going through, areas that were known to have contained ash or waste material because of their increased likelihood of transporting contamination. The proposed monitoring well locations were placed so as to intercept these flow paths.

Nine locations were drilled in the IHSS 133 series area in the attempt to install the four proposed monitoring wells. Groundwater was encountered in only three of the nine locations. The well locations that did not encounter groundwater were plugged, abandoned and reclassified as boreholes. Soil samples were collected from all of the wells/boreholes during drilling, and

groundwater samples are being collected on a quarterly basis from the one well that has been producing sufficient quantities of groundwater.

Zinc, barium, and antimony were detected at levels greater than BUTLs in one or two soil samples each. Plutonium-239/240 was detected at concentrations exceeding the BUTL in three soil samples taken from these wells/boreholes. Analytical results for metals indicated that the one well being sampled has metals concentrations in the groundwater exceeding BUTLs. Analyses of unfiltered samples from this well have detected 12 to 18 metals at concentrations exceeding BUTLs. Analyses of filtered portions of these same samples resulted in only manganese concentrations greater than the BUTL. This well has also contained above-background concentrations of americium-241 and radium-226.

A multiple-well aquifer pumping test was attempted at the one well that has contained groundwater in the IHSS 133 area. This test was unsuccessful (see Section 2.5.4.1.3 of Volume 2) and should be repeated (Section 3.2.2.2).

As indicated by the lack of success in locating wells that produce adequate groundwater in the IHSS 133 area, the hydrogeology of the area is incompletely understood and/or there is little or no groundwater present in this area. In either case, additional investigation is required to obtain information regarding the presence of groundwater in this area, hydrogeologic characteristics of the area, and the quality of any groundwater that may be present (Section 3.2.2.2).

### **2.2.5 Ambient Air Monitoring**

Ambient air monitoring activities associated with the site characterization of IHSS 133 were similar to those conducted for the investigation of IHSS 115 (Section 2.1.6). These activities are discussed in Section 2.5.5 of Volume 2 and are summarized in this section.

The RAAMP network and the special samplers for OU5 are discussed in Section 2.4.6.1 of Volume 2.. One OU5-specific sampler is positioned as an upwind sampler for OU5 while another is situated at a downwind location from IHSS 133. H&S monitoring for organic gases and radiation as described in Section 2.1.6 for IHSS 115 were also implemented for IHSS 133. Personal air sampling for asbestos-containing materials (ACM) was also conducted during those drilling operations when suspect material was encountered in IHSS 133.

The sampling results of the special OU5 sampler situated downwind of IHSS 133 are similar to those for the IHSS 115 downwind sampler. Examination of the special OU5 sampler data indicates that the uranium-233/234 and uranium-235 results are within the same order of magnitude for both the sampler downwind of IHSS 133 and the sampler upwind of OU5. These preliminary data seem to indicate no discernible contributions to ambient concentrations of either uranium-233/234 or uranium-235 from IHSS 133. This same analysis appears to apply also to plutonium-239/240 in the case of IHSS 133. The americium-241 and uranium-238 average concentrations for the downwind sampler are one order of magnitude greater than the average concentrations of the upwind sampler. Contributions to ambient concentrations of americium-241 or uranium-238 by IHSS 133 appear possible. In all cases, for all data, conclusions about possible radionuclide emissions from IHSS 133 can be made only after complete statistical analysis of validated data.

No elevated organic vapor levels were observed during field investigations of IHSS133. Elevated beta-gamma readings exceeding a background of <250 cpm were encountered during borehole activities at four locations. Levels of ACM were reported from the personal air sampler filters worn by H&S staff during work at eight borehole locations. The maximum sample result was 0.031 fibers per cubic centimeter. None of the results exceeded the American Conference of Governmental Industrial Hygienists (ACGIH) 8-hour Time Weighted Average occupational exposure limit of 2 fibers per cubic centimeter. The results indicate that there is some potential for release of ACM during ground disturbance activities in IHSS 133, such as additional field investigations or remediation.

### **2.3 IHSS 142.10 AND 142.11 (C PONDS)**

Section 2.6 of Volume 2 provides a detailed discussion of the methodology for and results of the Phase I investigation conducted thus far at IHSS 142.10 (C-1 Pond) and 142.11 (C-2 Pond). A summary of the information presented in Volume 2 is provided below. The locations of these IHSSs are shown on Figure 1.2-1.

#### **2.3.1 Stage 1**

The OU5 Work Plan specified that existing data regarding surface-water and sediment quality in Ponds C-1 and C-2 be evaluated. This evaluation was to determine the adequacy of the existing data in meeting the needs of the OU5 RFI/RI and if additional sampling was required to meet the RFI/RI objectives. The results of this evaluation were used to develop a revised FSP for surface-water and sediment sampling activities as presented in TM1 (EG&G 1993b). The results of this evaluation are discussed in Section 2.6.1 of Volume 2 and are also presented in detail in TM1 (EG&G 1993b) and EG&G (1994a).

### **2.3.2 Stage 3**

Stage 3 activities related to the investigation of Ponds C-1 and C-2 consisted of additional surface-water and sediment sampling and the installation and monitoring of well points along Woman Creek and its tributaries. These activities are discussed in detail in Section 2.6.2 of Volume 2 and are summarized in this section.

#### **2.3.2.1 Surface-Water and Sediment Sampling**

The OU5 Work Plan stipulated the collection of surface-water and sediment samples as part of the Phase I investigation of Ponds C-1 and C-2. Although a TM was not explicitly called for in the OU5 Work Plan, it did imply that this sample collection program may require modification based upon the review of existing data (Section 2.2.1). TM1 (EG&G 1993b) was prepared to provide a revised FSP for the Stage 3 investigation of these IHSSs. TM1 also addressed surface-water and sediment monitoring activities for all OU5 IHSSs (Section 2.1.3.4).

The results of the surface-water and sediment sampling activities at Ponds C-1 and C-2 are detailed in EG&G (1994a). Sampling activities conducted at the ponds consisted of HydroLab surveys to develop depth profiles of surface water at both ponds and a one-time collection of sediment samples from both ponds.

General conclusions from the 1992-1993 C-pond HydroLab profiles are that relatively constant conditions exist with depth during the months of April, August, October, and November. It is further concluded that both thermal and chemical stratification of the C-ponds is very weak to non-existent during all months of the year.

Based upon the pond-sediment concentrations, it is concluded that contaminants in the pond sediments may consist of mercury, barium, calcium, and zinc. Further statistical tests will be undertaken to assess, based upon the available limited database, if these small number of BUTL exceedance concentrations actually constitute potential Pond C-1 and C-2 contaminants, or if uncertainties in both the actual and background data only make it appear that these concentrations can be concluded to be site contaminants.

#### 2.3.2.2 Well Point Installation and Monitoring

Interactions of surface water and ground water along Woman Creek have been historically inferred from informal observations that sections of the Creek gain and lose water as the Creek transverses the RFP. The variation in gaining and losing water quantities is most likely transient, that is, it varies during the year and from year to year, depending upon the streamflows and positions of the water table in the Woman Creek alluvial deposits. Delineation and quantification of surface-water/groundwater interactions in Woman Creek and in OU5 in particular, is important for surface-water, groundwater and risk-assessment modeling (EG&G, 1993g).

As part of the OU5 Phase I RFI/RI investigation a series of shallow well points were installed along Woman Creek and its tributaries to monitor water levels. The information obtained from this program is used in conjunction with gain/loss flow measurements being taken in the Woman Creek as part of a different program. Thirty-six well points were installed along Woman Creek as outlined in TM1 (EG&G, 1993b). The well points were located to coincide with Woman Creek channel gain/loss sites used to measure streamflows in Woman Creek by Colorado State University (CSU) and EG&G. Water levels were measured in these well points on a monthly basis for one year to confirm if gaining and losing reaches of Woman Creek were based upon

the head difference in the shallow alluvial groundwater and the water-surface elevations in Woman Creek adjacent to the well point. The results of the well point and gain/loss measurements are discussed in detail in Section 2.6.2.2 of Volume 2.

Based upon data collected during the December 1991 through October 1992 period (Fedors and Warner, 1993) and during the March 1993 through February 1994 period, the individual reaches of Woman Creek can be characterized as generally gaining or losing water during certain periods of the year. Two reaches of Woman Creek and its tributaries can be identified as generally gaining water from the shallow groundwater system on nearly a year-round basis. Of note is the fact that one gaining reach is adjacent to IHSS 115, the Original Landfill, and one reach is downgradient from the old firing range. These gaining reaches may be significant receptors of contaminants from known sources within the Original Landfill and OU2, respectively.

### **2.3.3 Stage 4**

Stage 4 activities at IHSSs 142.10 and 142.11 consisted of the installation and sampling of groundwater monitoring wells. Section 2.6.4 of Volume 2 discusses the results of these activities, and they are summarized in this section.

#### **2.3.3.1 Groundwater Investigation**

According to the OU5 Work Plan (DOE, 1992), four monitoring wells were to be installed below IHSSs 142.10 and 142.11 as part of the OU5 Phase I RFI/RI. Two wells were installed immediately downgradient of each dam at Ponds C-1 and C-2 to monitor the saturated alluvium. All of these wells were installed in the locations specified in the OU5 Work Plan. Soil samples were collected from these wells during drilling and the wells below Pond C-1 have been sampled

on a quarterly basis when sufficient groundwater is present. The wells below Pond C-2 have not produced sufficient water for sampling. One well, located below Pond C-1, was also selected for field characterization of aquifer parameters.

None of the soil samples collected from the wells contained TAL metal concentrations exceeding BUTLs. One soil sample each from two wells contained above-background activities of plutonium-239/240 and one sample contained an above-background activity of americium-241. Both radionuclides were detected in composite samples from drums of cuttings that represented the upper 15 ft of each well. None of the soil samples collected from the wells contained pesticides or PCBs in concentrations exceeding BUTLs. No identified SVOCs were detected in soil samples collected from any of the wells, however, tentatively identified compounds (TICs) were detected in soil samples from all four of the groundwater monitoring well boreholes. VOCs (acetone, methylene chloride, and toluene) were detected in soil samples collected from all four monitoring well boreholes.

Three groundwater samples collected from the wells below Ponds C-1 and C-2 had metal concentrations exceeding BUTLs. Most of the results that exceeded BUTLs were for unfiltered samples. All of these samples were collected from the wells below Pond C-1. Samples from these same wells have also had radium-226 (total) and gross beta (dissolved) activities that exceeded BUTLs and detectible SVOCs. Samples from the wells have also contained concentrations of chloride and total suspended solids that exceeded BUTLs. None of the groundwater samples collected from these wells contained pesticides, PCBs or VOCs.

A multiple-well aquifer pumping test was successfully completed on one of the wells located below Pond C-1.



---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 2.0, Rev. 0  
**Page:** 2-35  
**Organization:** ER OU 5, 6 & 7 Closures

---

## **2.4 IHSS 209 AND OTHER SURFACE DISTURBANCES**

Section 2.7 of Volume 2 provides a detailed discussion of the methodology for and results of the Phase I investigation conducted thus far at IHSS 209, the Surface Disturbance West of IHSS 209, and the Surface Disturbance South of the Ash Pits. The locations of these IHSSs are shown on Figures 2.4-1 and 2.4-2. A summary of the information presented in Volume 2 is provided below.

### **2.4.1 Stage 1**

In accordance with the OU5 Work Plan, a review of aerial photographs and oblique photographs covering IHSS 209 and the two other surface disturbance areas was completed on September 23, 1992. These photographs were reviewed to assess the location and history of the surface disturbances. The results of the aerial photograph review are discussed in Section 2.7.1 of Volume 2 and are summarized below.

IHSS 209 consists of disturbed ground, as shown on Figure 2.4-1, that extends from the southwest to the northeast for a distance of approximately 1,200 ft. Two ponds or seeps are also present within this area. The aerial photographs indicate that the vegetation and upper sediments had been stripped from the area prior to 1955 and that prior to 1964 several pits had been opened within the site. The review of the photographs subsequently resulted in an extension of the overall length of the IHSS as compared to the dimensions shown on Figure 2-7 of the OU5

Work Plan, and some adjustments to the locations of the pits that were shown on Figure 2-7 of the OU5 Work Plan.

The Surface Disturbance West of IHSS 209 consists of eight pits that are first visible on a 1955 vertical aerial photograph of the RFP area (Figure 2.4-1). The Stage 1 aerial photo review resulted in relocating the pits approximately 250 ft to the north with respect to the locations shown on Figure 2-7 of the OU5 Work Plan. Three additional pits were identified as a result of Stage 1 activities and confirmed during the Stage 2 field reconnaissance (Section 2.4.2.1).

The Surface Disturbance South of the Ash Pits is shown on Figure 2.4-2 and consists of an area of disturbed ground, and an area that contains two open and two reclaimed pits. The area containing the disturbed ground comprises the southwest end of the site and is approximately 1,000 ft in length, and from 50 to 150 ft in width. The open and reclaimed pits are located in the northeast half of the site. The locations of the pits shown on Figure 2.4-2 have been corrected as a result of Stage 1 activities, according to scaled locations from the aerial photographs, and do not agree with the locations shown on Figure 2-6 of the OU5 Work Plan.

#### **2.4.2 Stage 2**

Stage 2 activities at IHSS 209 and the other surface disturbances consisted of a visual inspection of each site to confirm the information obtained in Stage 1 and to determine if any debris or staining indicative of waste disposal are present. Stage 2 also involved the performance of surface radiological surveys over each site. The results of these activities are discussed in detail in Section 2.7.2 of Volume 2 and summarized in this section.

#### 2.4.2.1 Visual Inspection

A visual inspection/site reconnaissance of IHSS 209 and the other surface disturbances was conducted on September 24, 1992. The following paragraphs summarize the results of this inspection for each site.

IHSS 209 As a result of Stage 2 reconnaissance, the pond southwest of the road near the center of the site was found to be at least 10 ft in depth and dry. The pits shown throughout the area are small, shallow excavations that are still open or partially backfilled. There is no evidence that these pits were ever used for the disposal of waste materials. The Stage 2 field reconnaissance confirmed the overall reconfiguration of the site, resulting from Stage 1 activities, and that no significant debris or staining exist to indicate that any waste disposal had occurred. It appears that the largest disturbance on the northeast end of the area may have been used as a source of gravel prior to 1955.

Surface Disturbance West of IHSS 209. The Stage 2 field reconnaissance confirmed the locations of all eight pits identified on the aerial photographs. The largest pit is located near the center of the site and was found to be several feet deep. The largest pit was dry at the time of the inspection but holds water during periods of wet weather or snow melt, and is now the host for a fairly large cottonwood tree indicating that the sight has been open for a long period of time. The remaining pits are small and shallow, appear to be capable of holding water during wet weather, and are heavily revegetated. There is no indication that any of these pits had ever been used as disposal sites. It is unclear what use the pits may have served. The OU5 Work Plan speculated that these pits may have been part of a planned radio-tower installation. The reconfiguration of these pits and the fact that the pits are located on a hillside rather than the top of the hill indicate that this may not be the case.

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual: 21100-WP-OU05.1  
Section: 2.0, Rev. 0  
Page: 2-38  
Organization: ER OU 5, 6 & 7 Closures

---

Surface Disturbance South of the Ash Pits. The field reconnaissance of the Surface Disturbance South of the Ash Pits confirmed the existence of the features noted in the OU5 Work Plan and identified on the aerial photographs. The disturbed area located in the southwest half of the site consists of cobble and small boulder size rocks of the Rocky Flats Alluvium, and appear to have been disturbed by some unknown surface activity. There is, however, no staining or debris associated with the site that would indicate any waste disposal had occurred.

#### 2.4.2.2 FIDLER Surveys

Section 7.2.4 of the OU5 Work Plan specified that IHSS 209 and the other surface disturbances be surveyed with a FIDLER. The results of this survey were to be used to modify, if necessary, the Stage 3 sampling activities at these sites. The surface radiological survey specified by the OU5 Work Plan was to be performed randomly at each of the surface disturbance sites. However, to ensure that the survey of each site was thorough, the surveys were performed on a grid as described in Section 2.7.2.2 of Volume 2. The pond/seep area located northeast of IHSS 209 was surveyed randomly.

The FIDLER surveys of IHSS 209 and the other surface disturbances did not identify any areas of above-background radiation. The random survey of the pond/seep area on the northeast side of IHSS 209 also did not indicate any above-background levels of radiation. The results of these surveys, therefore, did not necessitate any modifications to the Stage 3 sampling activities discussed in the following sections.

### 2.4.3 Stage 3

Stage 3 activities at IHSS 209 and the other surface disturbances consisted of the collection of surface and subsurface soils. Samples of surface water and sediments in the water-filled pits at IHSS 209 were also collected under Stage 3. These activities are discussed in Section 2.7.3 of Volume 2 and summarized in this section.

#### 2.4.3.1 Surface-Water and Sediment Sampling

The OU5 Work Plan specified the collection of samples of surface water, if present, and sediments from the pond-like depressions at IHSS 209. Two surface-water samples were collected from these locations. No concentrations exceeding BUTLs were noted for radionuclides, metals, or priority pollutants (organic constituents) associated with these resultant analyses. "Sediment" samples were collected from these depressions when no water was present in them during the surface soil sampling program discussed in Section 2.4.3.2.

#### 2.4.3.2 Surface Soil Sampling

The surface soil sampling program for IHSS 209 and the other surface disturbances is described in the OU5 Work Plan and in TM10 (EG&G 1993h). TM10 proposed that 19 surface soil samples be collected at three sites. The sample locations are coincident with pits, former excavation sites or ponds that were identified during the Stage 1 review of aerial photographs. TM10 also proposed that surface soil samples be collected at radiological survey anomalies. As discussed in Section 2.4.2.2, no anomalies were identified by the FIDLER survey of these sites. Section 2.7.3.2 of Volume 2 discusses the surface soil sampling program in detail.

None of the samples contained metals, pesticides, or PCBs in concentrations that exceeded background levels. Eight of the 19 surface soil samples contained plutonium-239/240 activities exceeding the BUTL, and four of the eight samples also contained americium-241 activities greater than the BUTL. The samples with above-background activities of radionuclides were collected from all three of the surface disturbance sites. The plutonium-239/240 activity (approximately 5 picocuries per gram (pCi/g)) of one sample collected at the Surface Disturbance West of IHSS 209 was the highest detected in surface soil samples from any of the OU5 IHSSs. Seven surface soil samples also contained detectable concentrations of SVOCs.

#### **2.4.3.3 Soil Borings**

As part of the investigation for IHSS 209 and the other surface disturbances, the OU5 Work Plan proposed drilling 19 boreholes to a depth of 12 ft. Three boreholes were to be located in IHSS 209, five boreholes were to be located in the Surface Disturbance West of IHSS 209, and 11 boreholes were to be located in the Surface Disturbance South of the Ash Pits. TM10 was prepared after preliminary investigations were completed at these locations. Based on information obtained during previous stages of the investigation, TM10 proposed drilling only four boreholes, one at the Surface Disturbance West of IHSS 209 and three at the Surface Disturbance South of the Ash Pits. Section 2.7.3.3 of Volume 2 discusses the rationale for reducing the number of boreholes as well as the results of the borehole program.

Soil samples were collected from each of the boreholes, and, if groundwater was present, a one-time groundwater sample was to be collected. None of the boreholes drilled at the surface disturbances encountered groundwater. The analyses of the soil samples identified one sample in which the concentration of chromium exceeded the BUTL. No other metals concentrations exceeded their respective BUTLs. One sample contained a plutonium-239/240 activity greater

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 2.0, Rev. 0  
**Page:** 2-41  
**Organization:** ER OU 5, 6 & 7 Closures

---

than the BUTL. No other radionuclides were detected exceeding BUTLs in the samples collected from these boreholes. Pesticides and PCBs were not detected in any of the samples collected. Benzoic acid, a SVOC, was detected in at least one sample from each of the boreholes. Methylene chloride was also detected in several samples.

With the exception of the results for surface soils at these sites, the results of the investigations conducted at IHSS 209 and the other surface disturbances do not indicate that these sites were ever used for the disposal of waste. The elevated levels of radionuclides, specifically plutonium-239/240 and americium-241, in surface soil samples do indicate that further investigation of potential surface contamination is warranted (Section 3.4.2.1).

### 3.0 AMENDED PHASE I FIELD SAMPLING PLAN

This section provides an amended Phase I FSP for several OU5 IHSSs. Each of the following subsections describe the data needs identified through the evaluation of the information summarized in Section 2.0 of this TM and then outline an amended FSP for each IHSS.

#### 3.1 IHSS 115 (ORIGINAL LANDFILL) AND IHSS 196 (FILTER BACKWASH POND)

Based upon analyses of data collected at IHSS 115, a program of additional sampling and analyses has been formulated. The details of this additional work, as well as the rationale for it, are presented in the following subsections.

##### 3.1.1 Data Needs

Intrinsic Air Permeability Test Evaluation. As presented in Section 2.1.2.2, a small-scale intrinsic air permeability study resulted in calculated permeabilities that were orders of magnitude greater than expected for clayey soils. This difference needs to be investigated.

Geotechnical Evaluation. If leaving waste in-place is considered an option for final disposition for the Original Landfill, the long-term stability, in terms of catastrophic or detrimental movements, needs to be addressed and the following data need to be obtained:

- surface and subsurface geometry of Original Landfill;
- surface and subsurface geometry of the existing slump, both prior to and subsequent to movement; and
- geotechnical parameters of soils and waste, including shear strength.



---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual: 21100-WP-OU05.1  
Section: 3.0, Rev. 0  
Page: 3-2  
Organization: ER OU 5, 6 & 7 Closures

---

There are numerous existing boreholes in and near IHSS 115 that will be used to obtain some of these data. However, their use will be limited because they were installed for the collection of environmental data not specifically for the collection of geotechnical data.

In addition, the bedrock beneath or near the Original Landfill, and possible hydraulic connection between the alluvial material and bedrock needs to be characterized due to the indicated presence of sandstone in the vicinity of the Original Landfill (EG&G, 1992e).

Groundwater Investigation. Given that many proposed monitoring well locations drilled during OU5 Phase I RFI/RI activities were not installed because the boreholes did not indicate or produce groundwater, the presence of groundwater and potential groundwater migration pathways downgradient of the Original Landfill need to be further characterized. This information is required for both the nature and extent evaluation and the groundwater modelling. Additionally, groundwater levels need to be monitored at IHSS 115 in order to provide the necessary input for the hydrogeologic model.

Storm Sewer Investigation. Only one sample was collected at the storm sewer outfall. This is not a sufficient amount of samples collected to understand what, if any, contamination is carried by the storm sewer. Additional samples will need to be collected during various flow periods to better understand the nature and extent of contamination.

Air Monitoring. TM12, which evaluated the potential exposure scenarios associated with OU5, concluded that re-suspension of contaminated surface soils from IHSS 115 by wind is an insignificant potential exposure pathway (EG&G, 1993i). Insignificant potential exposure pathways will be quantitatively evaluated.

The potential for re-suspension of contaminated soil has not been directly addressed in the investigation of IHSS 115. To make this evaluation, a selection of a corrected threshold friction velocity of the soil is necessary. The threshold friction velocity is the minimum wind speed required to cause surface particle movement. Phased investigation procedures to acquire corrected threshold friction velocity data for IHSS 115 are outlined in Section 3.1.2.4.

TM12 (Exposure Scenarios) concluded that inhalation of chemicals that have volatilized from site soils or groundwater are negligible exposure pathways (EG&G, 1993i). As of March 25, 1994, TM12 was not finalized. In the event that exposures to volatilized chemicals from IHSS 115 are determined to be exposure pathways of some significance, then additional field work will be required to investigate the emission rates of volatile species from the Original Landfill. A field technique for measuring the emission rates of volatile species is described in Section 3.1.2.4.

### **3.1.2 Field Sampling Plan**

This section details the amended FSP for IHSS 115, including IHSS 196. Table 3.1.2-1 summarizes the amended FSP.

#### **3.1.2.1 Intrinsic Air Permeability Test Evaluation**

As presented in Section 2.1.2.2, a small-scale intrinsic air permeability study resulted in calculated permeabilities that were orders of magnitude greater than expected for clayey soils. Two possible explanations for this discrepancy are that the soils at the test sites are not clayey or that short circuiting of the vapor flow path occurred during the test. Because the test was conducted in the same manner as the soil gas survey, it is possible that short circuiting occurred

during the survey, and that the observed soil gas concentrations are lower than those actually occurring in the subsurface formation.

To assess the likelihood of each explanation, recorded survey vacuum pressures will be reviewed, along with the borehole logs for nearby areas. In those locations where vacuum readings are not greater than background and the soil lithology is known to be of low permeability, short circuiting may have occurred. Laboratory data for soils in those areas will also be reviewed for correlation. If those areas at which low vacuum readings occurred were not covered by other analyses, such as for soil or groundwater, re-sampling at very low vacuum pressures will be conducted. Procedures and analyses will be conducted in accordance with TM5. The samples will be analyzed for 1,1,1-TCA, benzene, carbon tetrachloride, DCM, TCE, and PCE.

#### 3.1.2.2 Geotechnical Evaluation

The stability of the slopes along IHSS 115 will be analyzed using a method of slices analysis. Key inputs to this type of analysis are the geometry of the slopes, subsurface materials, and strength characteristics of the subsurface materials (waste, alluvium, and bedrock). A preferred method of characterizing the strength parameters of the subsurface materials is to back calculate them from an existing failure. The slump that exists below the former drainage ditch and above the SID appears to provide the required information to perform these calculations. In order to obtain this information and the information necessary for calculating long-term stability, the following work elements or tasks have been identified:

- obtain information regarding the occurrence of the slump, including but not limited to, date of failure, speed of failure, and general climatic conditions;

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 3.0, Rev. 0  
**Page:** 3-5  
**Organization:** ER OU 5, 6 & 7 Closures

---

- obtain surface geometry before and after the slump occurred;
- obtain subsurface geometry; and
- characterize geotechnical properties of subsurface materials.

Information obtained from implementation of these four tasks will be combined into a fifth task which is the stability analyses. This task will include both back calculating strength parameters for the existing slump and using those values in calculating long-term stability for existing slopes.

It is hypothesized that the high clay content of the alluvium may result in such low hydraulic conductivities that groundwater is prevented from flowing into a borehole even though the interval may actually be saturated. These clay intervals appear to be only moist during well site logging though they may actually be saturated. Soil moisture data obtained during the geotechnical evaluation will be used to evaluate the degree of saturation of the subsurface materials. Again, this information is also important as input in the hydrogeologic model of OU5 and will supplement the information collected under the groundwater investigation (Section 3.1.2.3).

The first task involves searching through EG&G and DOE files for documentation of the slump rather than typical environmental issues as researched before. It includes collection and review of aerial photographs to characterize the dimensions of the slump. Large scale stereo pairs may provide the information required for characterizing the slump. It will also include collection and review of the 881 hillside, french drain geotechnical report (EG&G, 1990), and the Geologic Characterization Reports.

The second task consists of reviewing topographic maps prior to the slump. If a topographic map of an appropriate scale and contour interval (2-foot) cannot be located, large scale stereo pair aerial photographs may be used to estimate pre-slump topography.

For the third task, the subsurface geometry shall be obtained from boreholes. Locations of existing boreholes do not provide adequate areal distribution to characterize the subsurface geometry. Therefore, based on the overall visible width of the existing failure and the accessibility, thirteen boreholes shall be advanced 5-ft into claystone bedrock, as specified in SOP GT.2, Drilling and Sampling Using Hollow Stem Auger Techniques (Figure 3.1.2.2-1), on a grid of approximately 100 ft. (this spacing is similar to that used for both the CPT and Well Point investigations). Boreholes and soil samples will be logged in accordance with SOP GT.1, Logging Alluvial and Bedrock Material. All locations will be surveyed in accordance with SOP GT.17, Land Surveying (0.1 foot accuracy).

Up to five of the 13 boreholes may require the use of a hollow-stem auger (HSA) rig rather than a small footprint rig using the Kansas sampler. This is due to the estimated depth to bedrock to be on the order of 35 ft and the need for larger diameter samples. Also, the selection of a drill rig will be based upon the terrain and the ability of a full-sized drill rig to reach the proposed drill sites. A larger drill rig will provide the following advantages:

- it will be able to obtain 2.5-inch diameter samples for either direct shear or triaxial compression testing, and
- it will provide blow counts when sampling which can be use in the stability analyses.

Boreholes not advanced with a HSA rig will be advanced with a small all-terrain-vehicle rig capable of driving a Kansas sampler to the required depths. Information obtained from the

boreholes will provide input for both the stability analysis and the groundwater modeling. Depth-to-bedrock data will be used to revise the bedrock topography map of OU5.

Core samples from both types of boreholes will be retained in core boxes. Samples from the boreholes will not be submitted for chemical analyses. However, for HSA boreholes, composite samples from the drums will be submitted for waste characterization. If field screening indicates elevated readings in the small diameter boreholes, a second (or twinned) borehole will be advanced a few feet away. The core from the twinned borehole will be collected for chemical analyses. If field screening does not identify any anomalous readings in any of the boreholes, two small boreholes will be arbitrarily selected to be twinned and have samples collected for analyses. This will be done as a check on the effectiveness of field screening. The procedures for sample collection and analytes will be the same as specified in the OU5 Work Plan for boreholes within IHSS 115. These procedures and analytical parameters are summarized on Table 3.1.2-1.

Field quality control (QC) samples will be collected for both soil and groundwater samples. Duplicate samples will be collected with the frequency of one duplicate sample per 10 real samples. Rinsate samples will be collected with the frequency of one rinsate sample per 20 real samples or a minimum of one rinsate sample per day of sampling.

As part of the groundwater investigation, two locations (west end of Original Landfill north of well point 60493) will have piezometers constructed of 1/2-inch diameter PVC installed (Figure 3.1.2.2-1). These piezometers will provide water level data for the hydrogeologic model. The piezometers will be installed in accordance with SOP GT.6, Monitoring Wells and Piezometer Installation, and developed in accordance with SOP GW.2, Well Development. They will be

surveyed in accordance with SOP GT.17 Land Surveying (top of inner casing and protective casing measured to 0.01 foot accuracy vertically).

Soil samples will be collected as part of the fourth task in relation to stability analysis. Soil samples will be collected in 6-inch liners from the lower 6-inches of each sampling run in the HSA boreholes. Soil samples will be collected from every third sampler (approximately every 5 to 6 ft) through the entire depth of the boreholes. One soil sample from each of the five boreholes will be selected from the lower 2-ft of alluvium above the bedrock and analyzed for natural density (dry and moist), natural moisture content, Atterberg limits, and grain-size distribution (including hydrometer analyses), and ion-type analyses. Samples that are not selected for analysis will be retained in the core boxes.

A minimum of three (one of each material type - waste, alluvium, and bedrock) soil samples will be collected which consist of three 2.5-inch diameter, 6-inch long liners from each HSA borehole. Six of these (two of each material type - waste, alluvium, and bedrock) will be selected for analysis of natural density (moist and dry), natural moisture content, Atterberg limits, grain-size distribution (including hydrometer analyses), ion-type analyses, and, either, undrained unconsolidated triaxial compression tests (UU test) or direct shear tests. If a sample with a length to diameter ratio of 2:1 can be obtained, a UU test will be conducted. If however that ratio cannot be attained (ie. the material is non-cohesive), a direct shear test will be conducted on a sample remolded to approximately natural moist density. Samples that are not selected for analysis will be retained in the core boxes.

In addition to the ten samples listed in the previous paragraphs, soil samples will be obtained from the small diameter boreholes advanced with the Kansas sampler. Soil samples will be collected from every third sampler (approximately every 5 to 6 ft) throughout the entire depth

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 3.0, Rev. 0  
**Page:** 3-9  
**Organization:** ER OU 5, 6 & 7 Closures

---

of the boreholes. These samples will be analyzed for moisture content. One soil sample from each of these boreholes will be selected and analyzed for Atterberg limits and grain-size distribution (+200 fraction). These samples should be of material within the lower 2-ft of the alluvium above the bedrock.

The fifth task consists of both back calculating strength parameters of the subsurface materials and calculating the long-term stability at the Original Landfill in its current configuration. The stability will be analyzed using a method of slices analysis.

In addition to the geotechnical characterization discussed above, up to three boreholes will be drilled using a HSA rig to further characterize the bedrock beneath or near the Original Landfill, and investigate possible hydraulic connection between the alluvial material and bedrock. Locations will be selected based on a thorough review of the geologic data (including but not limited to the logs of OU5 specific boreholes and locations and trends of known sandstones). The locations and depths of these boreholes will be proposed to the EPA and CDH in a letter prior to implementation of the field work.

If greater than 6 feet of sandstone is encountered, 6 foot composite samples will be collected and analyzed, if less than 6 feet of sandstone is encountered only the sand will be composited and VOC samples will be collected on 2-foot intervals. Composite soil samples of alluvium will be collected in accordance with the procedures specified in TM7 for boreholes at IHSS 133 (EG&G, 1993e). In addition, discrete samples will be collected at 2-foot intervals for VOC analyses. Where groundwater is encountered in the sandstone, a monitoring well will be installed and sampled quarterly. If sandstone and ground water are not encountered, the boreholes will be plugged and abandoned.



### 3.1.2.3 Groundwater Investigation

In order to more completely evaluate the presence and quality of groundwater at and downgradient of the Original Landfill, additional groundwater samples need to be collected and analyzed. Since the presence and quantity of groundwater appears to be limited, this task shall consist of three work elements:

- 1) install and develop 5 mini-wells (Figure 3.1.2.2-1);
- 2) measure water levels in all well points, mini-wells, piezometers, and monitoring wells that are along or north of Woman Creek, south of the south Buffer-Zone access road, east of the western edge of IHSS 115 (approximately CPT07393), and west of the eastern edge of IHSS 115 (approximately CPT05393) on a monthly basis for one year; and
- 3) obtain samples from any location that is downgradient of the landfill if water level measurements indicate presence of a sufficient quantity of water.

The primary purpose of installing the five mini-wells is to further characterize the presence or absence of ground water. The five proposed mini-well locations are placed in 1) bedrock lows that were identified during the CPT investigation (but water was not detected), and 2) between existing well points. Of the five mini-wells to be installed, four shall be installed downgradient of IHSS 115 and one shall be installed on the upper level part of the eastern end of IHSS 115 in the vicinity of borehole 50792. This latter location will be used for only water level input for the hydrogeologic model and not sampling. These mini-wells will be installed using a small all-terrain vehicle rig which does not produce soil cuttings. Composite soil samples will be collected during drilling in accordance with the procedures outlined in TM7 (EG&G, 1993e). In addition, discrete samples will be collected at 2-foot intervals for VOC analyses. Analytical

parameters for soil samples will be the same as specified in the OU5 Work Plan (see Table 3.1.2-1).

Water levels will be measured in all the monitoring wells, well points, and piezometers located along or north of Woman Creek, south of West Road, east of the western Buffer-Zone boundary road, and west of First Street. This includes the piezometers along Woman Creek as discussed in a subsequent paragraph. Water level measurements will continue monthly for a year. This will characterize the magnitude of seasonal fluctuations and provide the hydrogeologic model an average level.

Groundwater samples shall be obtained from any well point or mini-well that is downgradient of the landfill (existing or new) if water level measurements indicate presence of a sufficient quantity of water. These samples will be collected quarterly for at least one year or when sufficient water is present, however, no more than four samples will be collected in one year. Groundwater samples will be collected in the priority listed on Table 3.1.2.3-1. Information from these work elements will be used for the evaluation of nature and extent, as well as input for the hydrogeologic model.

Field QC samples will be collected for both soil and groundwater samples. Duplicate samples will be collected with the frequency of one duplicate sample per 10 real samples. Rinsate samples will be collected with the frequency of one rinsate sample per 20 real samples or a minimum of one rinsate sample per day of sampling. Because groundwater sampling equipment is dedicated, the instrument probes used to measure field parameters will be rinsed to obtain the groundwater rinsate samples.

To further characterize the bedrock surface and thickness of the alluvium and valley fill along Woman Creek, three boreholes will be advanced 5-ft into claystone bedrock and be located as close to the creek bed as possible (Figure 3.1.2.2-1). These boreholes will be advanced as specified in SOP GT.2, Drilling and Sampling Using Hollow Stem Auger Techniques. Soil samples (core) will be collected continuously with a Kansas sampler. Core will be retained in core boxes. Boreholes and samples will be logged in accordance with SOP GT.1, Logging Alluvial and Bedrock Material. Piezometers will be installed in each borehole in accordance with SOP GT.6, Monitoring Wells and Piezometer Installation, and developed in accordance with SOP GW.2, Well Development. Piezometers will be surveyed in accordance with SOP GT.17 Land Surveying (top of inner casing and protective casing measured to 0.01 foot accuracy vertically). Since these locations are outside the IHSS boundaries, core will only be screened by field instruments.

A single-well pumping test will be performed at well 59593. This test will be performed when the static water level is higher than the static water level at the time the previous test was conducted. This will allow the unit to be stressed more than the previous test. As indicated in Section 2.1.4.3, analysis of the data collected during the slug test performed during 1993 at this location indicated that the data was not reliable enough to make confident judgements with regard to hydrogeologic characteristics in the vicinity of this well.

#### 3.1.2.4 Storm Sewer Sampling

In order to more completely evaluate the nature and extent of contamination carried by the storm sewer system, additional samples need to be collected during various flow periods. Therefore, the storm sewer outfall (monitoring site SW500) will be included in the current surface water sampling program. Samples will be collected quarterly such that two samples will be collected

during high flow events and two samples will be collected during low flow events. These samples will be collected in accordance with SOP SW.03 Surface Water Sampling and will be analyzed for the same suite of constituents as analyzed for during earlier OU5 Phase I RFI/RI field work (i.e., radionuclides, TAL metals, water quality parameters, and VOCs).

#### 3.1.2.5 Air Monitoring

Radioactive Ambient Air Monitoring Program (RAAMP). Ambient air monitoring by the existing RAAMP network will continue for the entire facility. Modifications to the RAAMP network are planned (EG&G, 1993j). Several changes relate to OU5 as well as to broader areas of the facility. A new on-site RAAMP sampler is planned for installation during the summer 1994 in the lower Woman Creek drainage below Pond C-2. Also, a new perimeter RAAMP sampler will be added in 1994 at the location of the closest residence at the southeast corner of the RFP buffer zone. In 1995, RAAMP samplers S-13 and S-14 will be removed from the network.

Special OU5 Ambient Air Samplers. Plans are to continue operation of the special OU5 ambient air samplers (S-100, S-101, and S-102) as regular components of the RAAMP. As discussed in Section 2.1.6, future sample analyses and data validation results will be evaluated for possible indications of any specific contribution of IHSS 115 to ambient levels of radionuclides.

Wind Re-suspension Potential. The investigation of the wind erosion potential of contaminated soils from IHSS 115 is proposed as a phased approach. The first phase involves a limited field investigation of the site and comparisons of these results with those of a more intensive study that was performed at OU3. If the first phase results are inconclusive, then a second phase is

recommended. The second phase would be the replication at OU5 of the intensive field studies that were conducted at OU3, discussed below.

The first phase of the IHSS 115 investigation begins with rapid assessment field investigation according to the methodology described by Cowherd et al. (1985). The field investigation consists of observations about the extent of vegetation, presence of soil crustal material, characterization of the crust, soil sieving, and an analysis for correcting for non-erodible elements. Procedures for quantifying the extent of vegetation, presence of soil crustal material, characterization of the crust, and soil sieving are described in Cowherd et al. (1983). These procedures will be conducted in conformance with the applicable requirements of the EG&G Rocky Flats, Inc. Environmental Management Division Operating Procedures Manual (1994). The result of the field survey will be the determination of the threshold friction velocity of the contaminated surface soil at IHSS 115. The threshold friction velocity is the minimum wind speed required to cause surface particle movement.

The *OU3 Wind Tunnel Study* (EG&G Rocky Flats, Inc. 1994) measured the threshold friction velocities at four undisturbed terrestrial sites. The range of the individual results ( $> 160$  cm/s,  $> 170$  cm/s,  $> 180$  cm/s, and  $> 280$  cm/s) was narrow. The soil and vegetation conditions of these sites were not well characterized in the text of that report. The first activity will be a field examination of these four undisturbed terrestrial sites within OU3 in order to record in descriptive detail the soil and vegetation conditions. One soil sieve measurement and one nonerodible element correction factor,  $L_c$ , estimate will be made at each site according to the rapid assessment method.

The areas of interest in OU5 are those where radionuclides in the surface soils are above the background upper tolerance limits: IHSS 115, IHSS 133, and IHSS 209 and the other surface

disturbances on the south side of the Woman Creek Drainage. The soil and vegetation conditions of these areas will be examined for comparison with the conditions of the four OU3 undisturbed terrestrial sites. The purpose of this comparison is to evaluate whether the soil and vegetation conditions of OU3 are similar or different to those at OU5. To this extent, in the field the comparison will be qualitative.

Each area of interest in OU5 will be examined also for homogeneity of soil and vegetation conditions. If the area is homogeneous, 5 soil sieve samples will be measured within the area. That is, a total of 25 sieve samples will be measured for the 5 areas of interest. If an area is not homogeneous, 5 samples will be measured within each sub-area of relative soil and vegetation uniformity. Along with each soil sieving procedure, a measurement of a correction factor for nonerrodible surface elements,  $L_c$ , will be taken.

Results of the first phase rapid assessment field investigation of IHSS 115 will be compared with the results of the direct measurement of threshold friction velocities of soils at OU3 (EG&G, 1994b). These direct measurements were made in situ with a portable wind tunnel. As well as measuring the soil friction velocities of the soils, the OU3 study calculated the emission rates of suspended particulate matter and inhalable particulate matter ( $PM_{10}$ ) and the  $PM_{10}$  erosion potential of the soils. If the OU5 rapid assessment field investigation results compare within the same order of magnitude of the OU3 wind tunnel study results, then the IHSS 115 investigation will be considered complete at this first phase.

The second phase of field study, to determine the wind erosion potential of contaminated soils, is advised only if the rapid assessment procedures of the first phase are unable to provide reliable threshold friction velocities and particulate matter emission rates. The second phase would consist of a replication of the OU3 wind tunnel studies to directly measure threshold

friction velocities at OU5 and would be documented in a letter provided to EPA and CDH for approval prior to implementation. This phase of work would be initiated and controlled by the EG&G Air Quality Department. The technology to be used is described in detail both in the OU3 wind tunnel study (EG&G, 1994b) and an EPA Superfund guidance document (EPA, 1989).

The Cowherd wind tunnel (Figure 3.1.2.4-1) is a portable wind tunnel developed to measure particulate matter emissions from open waste piles. The open-floored test section of the tunnel is placed directly over the test surface. Air is drawn through the tunnel at controlled velocities to simulate wind conditions. The exit air passes through a duct fitted with a probe to isokinetically sample the air stream by a high-volume sampling train. The sampling train consists of a trapper probe, cyclone precollector, parallel-slot cascade impactor, backup filter, and high-volume motor. A blower located downstream of the sampling train provides air flow.

The emission flux is calculated from the isolated surface area, emission concentration, simulated wind speed, and time period during which particulates are collected. Because the emission concentration is collected over time, the technology measures the overall (time-integrated) emission rate rather than the emission flux. Varying the simulated wind speed between measurements allows for development of a weighted average emission rate. This is preferred to using an average wind speed because the total erosion may be greatly influenced by infrequent periods of high wind speed.

The loss of erodible material is calculated as:

$$E_i = (C_i Q t) / A,$$

where  $E_i$  = emission rate of component  $i$  ( $\text{g}/\text{m}^2$ ),  
 $C_i$  = average particulate concentration of component  $i$  in tunnel exit stream ( $\text{g}/\text{m}^3$ ),  
 $Q$  = tunnel flow rate ( $\text{m}^3/\text{s}$ ),  
 $t$  = duration of sampling time (s), and  
 $A$  = exposed test area ( $\text{m}^2$ ).

Elimination of the time factor in the calculation will provide an emission flux on a unit area per time basis ( $\text{g}/\text{m}^2\text{-s}$ ). The average particulate concentration ( $C_i$ ) may be reduced to account for background dust levels by sampling under light wind conditions and subtracting the resulting average concentration from  $C_i$  values generated during simulations of higher wind conditions.

Volatilization of Gases. If inhalation of volatile chemical species emitted from areas of IHSS 115 by workers or future residents outdoors is eventually decided to be an exposure pathway of concern, then additional field work will be required to measure the emission rates of these volatile gases. As specified in TM 12 (EG&G, 1993i), this exposure scenario is not considered a complete exposure pathway at the present time. The investigation would be confined to those sections of the landfill identified as having anomalous concentrations of VOCs by the soil gas survey (Section 2.4.2.2). The scope and procedures for this investigation will be documented in a letter provided to EPA and CDH for approval prior to implementation.

The emission isolation flux chamber is one of the preferred in-depth technologies for the direct measurement of volatile species emission rates. A description of the methodology and applicability of the apparatus is given by EPA (1989). The technology uses a surface enclosure



(flux chamber) to isolate a known surface area for emission flux (rate per area) measurement. The emission isolation flux chamber for solid surfaces is illustrated in Figure 3.1.2.4-2.

Emissions enter the open bottom of the chamber from the exposed surface. Clean, dry sweep air is added to the chamber at a metered rate. Within the chamber, the sweep air is mixed with emitted gases by the physical design of the sweep air inlet. The sweep air creates a slight wind velocity at the emitting surface, preventing a build up of the emission concentration in the boundary layer directly above the surface. The exit port is used for measuring the concentration of the air within the chamber or for sampling and subsequent analysis.

This technology directly measures essentially an instantaneous emission flow (flux) from that surface. The emission flux is calculated from the surface area isolated, the sweep air flow rate, and the emission concentration. Statistical methods are used to determine the number of measurement locations required to characterize the emissions from an area source. These methods are based on the surface area of the source and the variability (precision) of the measured emission rate at randomly selected locations across the site. Use of the emission isolation flux chamber is described in the draft "Measurement of Gaseous Emission Rates from Land Surfaces Using an Emission Isolation Flux Chamber User's Guide" (Keinbusch, 1986). The emission isolation flux chamber was validated for EPA (using standard methods) for measuring volatile emissions from landfills (Eklund, et al., n.d.; Keinbusch, 1986).

The emission flux is calculated as:

$$E_i = (C_i Q) / A,$$

where  $E_i$  = emission flux of component  $i$  ( $\mu\text{g}/\text{m}^2\text{-min}$ );  
 $C_i$  = concentration of component  $i$  at chamber outlet ( $\mu\text{g}/\text{m}^3$ );  
 $Q$  = sweep air flow rate into chamber ( $\text{m}^3/\text{min}$ ); and  
 $A$  = surface area enclosed by chamber ( $\text{m}^2$ ).

The emission isolation flux chamber is applicable to emission flux measurement from all types of area sources, including landfills, open dumps, and waste piles. It is applicable with modifications to liquid surfaces. The technology can be used at open and closed landfills, with or without internal gas generation. It can be used to assess emission rates from cracks in the surface cover and from vents with minimal or no volumetric flow. It is applicable both for undisturbed and disturbed site conditions and for the testing of emissions control technologies.

The emission fluxes of volatile species may be enhanced or suppressed since the flux chamber alters the environmental conditions (e.g., wind speed, ambient temperature) at the sampling locations. The technology does not assess the effects of ambient meteorological conditions on the emission rate. The technique is not particularly well suited to large emission sources with a high degree of heterogeneity. Comparison of sample data and variability can determine the number of sampling locations needed to determine representative area emissions. The technology is not applicable to the measurement of particulate emission fluxes.

### 3.2 IHSS 133 (ASH PITTS, INCINERATOR, AND CONCRETE-WASH PAD)

Based upon analyses of data collected at IHSS 133, a program of additional sampling and analyses has been formulated. The details of this additional work, as well as the rationale for it, are presented in the following subsections.

### 3.2.1 Data Needs

Investigation of TDEM Anomalies. As discussed in Section 2.2.2.2, the TDEM survey of the IHSS 133 area identified several anomalies that require further investigation. A comprehensive field inspection of all TDEM anomalies is required to separate anomalies due to surface metallic debris from buried metallic debris in trenches and ash pits. Once the anomalies caused by surface metallic debris have been eliminated, additional soil boreholes and soil sampling may be required to confirm the presence of wastes buried in the new trenches and pits as characterized by the TDEM data.

Groundwater Investigation. Given that many proposed monitoring well locations drilled during OU5 Phase I RFI/RI activities were not installed because the boreholes did not indicate or produce groundwater, the presence of groundwater and potential groundwater migration pathways in the IHSS 133 area need to be further characterized. This information is required for both the nature and extent evaluation and the groundwater modelling. Additionally, groundwater levels need to be monitored at IHSS 133 in order to provide the necessary input for the hydrogeologic model.

Air Monitoring. The potential for re-suspension of contaminated soil has not been directly addressed in the investigation of IHSS 133. To make this evaluation requires a determination of the corrected threshold friction velocity of the soil. The phased investigation procedures to acquire corrected threshold friction velocity data for IHSS 115 (Section 3.1.2.4) are applicable to IHSS 133.

Due to the fact that any VOCs would have been destroyed during the incineration process, volatile chemical species are not a concern at IHSS 133. Therefore, no field work to measure the emission rates of volatile species is proposed for IHSS 133.

### **3.2.2 Field Sampling Plan**

This section details the amended FSP for the IHSS 133 sites. Table 3.2.2-1 summarizes the amended FSP for the IHSS 133 sites.

#### **3.2.2.1 Investigation of TDEM Anomalies**

The results of the TDEM survey indicate that many geophysical anomalies are present throughout IHSS 133. Although some of these geophysical anomalies are associated with known trenches and ash pits, many more anomalies appear to exist in this area, but their origins are as yet unknown. These anomalies may be associated with either surface metallic debris not observed at the time of the survey due to snow cover, or previously unknown trenches and pits, which require further investigation.

Comprehensive field inspection will be performed over the entire geophysical survey grid to identify areas where surface metallic debris (i.e., cans and fence posts) is present. The source of the anomalies will be documented in field books or on maps and will include the approximate grid coordinates and type of debris. If a source cannot be identified for a mapped anomaly, this will be also documented. If anomalies are identified that cannot be associated with surface debris, additional work elements to investigate the source and characteristics of the anomalies will be proposed to EPA and CDH in a letter.

Soil boreholes will be drilled to geologically and chemically characterize the surface and subsurface materials within the four anomalous areas identified from the TDEM survey that seem to be associated with possible trenches (see discussion in Section 2.5.2.2.3 of Volume 2). These soil boreholes will also assist in assessing the lateral and vertical extent of the trenches and pits. Seven boreholes (Figure 3.2.2.1-1) will be drilled in these four anomalous areas. Specifically,

- one borehole will be located approximately 10 ft southeast of the concrete pad, in the north-central portion of IHSS 133,
- two soil boreholes will be advanced at a location approximately 25 ft north of IHSS 133.6 and 25 ft south of the dirt road underneath the power lines,
- one borehole will be drilled at IHSS 133.4, in the center of the TDEM anomaly associated with the northern trench, approximately midway between existing boreholes 55993 and 56093C, and
- three boreholes will be advanced on either end and the center of the geophysical anomaly between IHSS 133.3 and IHSS 133.4, approximately 20 ft south of the dirt road beneath the power lines.

All drilling and sampling activities will be conducted in accordance with the procedures outlined in TM7 and as defined by EG&G's SOPs. These soil samples will be analyzed for TAL metals, uranium-233/234, uranium-235, uranium-238, plutonium-239/240, americium-241, gross alpha, and gross beta. Ten percent of the soil samples collected will also be analyzed for grain-size distribution (+200 fraction).

Due to the overhead powerlines, it is anticipated that all of the drilling will be accomplished with small rigs using the Kansas sampler. This type of borehole also offers the advantage over HSA boreholes in that there are no cuttings and only small quantities of residual soil from sampling that need to be handled (disposed).

At borehole locations where groundwater is encountered an attempt will be made to obtain a groundwater sample. Groundwater will be sampled with either a Hydropunch II sampler operating in the hydrocarbon mode or a temporary well point. A length of dedicated (disposable) Teflon will be used in conjunction with a peristaltic pump to obtain groundwater samples from either sampling device. The quantity of groundwater may be limited and unfiltered samples will be collected in the following order of priority; 1) uranium-233/234, uranium-235, and uranium-238; 2) gross alpha and gross beta; 3) TAL metals; and 4) plutonium-239/240 and americium-241. Specific conductance, pH, temperature, and dissolved oxygen will be measured in the field provided the quantity of groundwater is sufficient according to appropriate SOP(s).

Field QC samples will be collected for both soil and groundwater samples. Duplicate samples will be collected with the frequency of one duplicate sample per 10 real samples. Rinsate samples will be collected with the frequency of one rinsate sample per 20 real samples or a minimum of one rinsate sample per day of sampling. Rinsates for groundwater samples collected with the Hydropunch II will be obtained by rinsing the sampling device and associated equipment. Because groundwater sampling equipment associated with temporary well points is dedicated, the instrument probes used to measure field parameters will be rinsed to obtain the groundwater rinsate samples for samples obtained using this technique.

### 3.2.2.2 Groundwater Investigation

Based on information from geologic logs of boreholes and monitoring wells in and around the IHSS 133 area with regard to bedrock topography and degree of saturation of soils, there are several areas where insufficient data exist. Nine soil boreholes will be advanced and small-diameter piezometers installed at these locations (Figure 3.2.2.2-1). Five of these boreholes will

be located as close to the creek bed as possible. These boreholes will be advanced as specified in SOP GT.2, Drilling and Sampling Using Hollow Stem Auger Techniques. Soil samples (core) will be collected continuously with a Kansas sampler. Geotechnical samples will also be collected at approximately 5-foot intervals from these boreholes and analyzed for natural moisture content. Core will be retained in core boxes. Boreholes and samples will be logged in accordance with SOP GT.1, Logging Alluvial and Bedrock Material.

Piezometers will be installed in each borehole in accordance with SOP GT.6, Monitoring Wells and Piezometer Installation, and developed in accordance with SOP GW.2, Well Development. Piezometers will be surveyed in accordance with SOP GT.17 Land Surveying (top of inner casing and protective casing measured to 0.01 foot accuracy vertically). Since these locations are outside the IHSS boundaries, core will only be screened by field instruments.

Depth to bedrock information will be used to revise the bedrock topography map of OU5 which will then be used as input for the hydrogeologic model. Moisture content data will be used to characterize the degree of saturation which is also required input for the hydrogeologic model.

Frequent water level elevation data are important input parameters to the hydrogeologic model. Water levels will be measured in all the monitoring wells, well points, and piezometers that are along or north of Woman Creek, south of the West Road, east of the west dirt perimeter road, and west of the eastern extent of the IHSS 133 area. Water levels shall be measured monthly for a year. This will characterize the magnitude of seasonal fluctuations and provide the hydrogeologic an average level.

Groundwater samples shall be obtained from any well points that are adjacent to or downgradient of an IHSS or TDEM anomaly (except the piezometers along Woman Creek) if water level

measurements indicate presence of a sufficient quantity of water. These samples will be collected quarterly for at least one year or when sufficient water is present, however, no more than four samples will be collected in one year. Groundwater samples will be collected in the priority listed on Table 3.1.2.3-1, with the exception that samples for VOCs will not be collected. Information from these samples will be used for the evaluation of nature and extent, as well as input for the hydrogeologic model.

A visual field survey will be performed along the length of Woman Creek downgradient of the IHSS 133 series area. The objective of this visual survey is to characterize where bedrock crops out in the stream channel, if at all. Location of bedrock outcrops will be documented in the field on a map of an appropriate scale and the character of the bedrock and outcrop will be documented in field books. This information will be used to revise the bedrock topography map and provide input to the hydrogeologic model.

The water level will be measured in monitoring well 58793 monthly for a year. If the water level rises above the permeable unit in this well (see Section 2.5.4.1-3 in Volume 2), an aquifer pumping test will be performed.

#### 3.2.2.3 Air Monitoring

Radioactive Ambient Air Monitoring Program (RAAMP). Ambient air monitoring by the RAAMP network will continue for the entire facility. The specific applicability of the RAAMP data to OU5 is limited. The presence of multiple sources throughout the facility precludes a determination of individual source contributions. RAAMP sampler filters are analyzed only for two radionuclides, plutonium-238 and plutonium-239.



Special OU5 Ambient Air Samplers. Plans are to continue operation of the special OU5 ambient air samplers (S-100, S-101, and S-102) as regular components of the RAAMP. As discussed in Section 2.4.6.3, future sample analyses and data validation possibly will provide some indication of any specific contribution of IHSS 133 to ambient levels of radionuclides.

Wind Re-suspension Potential. The investigation approach outlined for IHSS 115 (Section 3.1.2.4) is also recommended for IHSS 133.

### 3.3 IHSS 142.10 AND 142.11 (C PONDS)

Because additional surface-water data currently are being collected in OU5 as part of the ongoing area-wide monitoring at RFP, additional surface-water data are judged not to be needed. Based upon analysis of the historical and recent sediment-quality data, no additional bottom-sediment data needs have been identified at this time.

### 3.4 IHSS 209 AND OTHER SURFACE DISTURBANCES

Based upon analyses of data collected at IHSS 209 and other surface disturbances, a program of additional sampling and analyses has been formulated. The details of this additional work, as well as the rationale for it, are presented in the following subsections.

#### 3.4.1 Data Needs

Eight of the surface soil samples for plutonium-239/240 exhibited activity exceeding the BUTL and one of these, sample SS50075, was an order of magnitude greater than the BUTL. Four of the eight samples also exhibited americium-241 greater than the BUTL. Three of these

samples SS50075, SS50085, and SS50086 were an order of magnitude greater than the BUTL. Therefore, additional sampling for plutonium-239/240 and americium-241 in IHSS 209 and the other surface disturbances is recommended.

### **3.4.2 Field Sampling Plan**

The following sections outline the amended FSP for IHSS 209 and the other surface disturbances. Table 3.4.2-1 summarizes the amended FSP.

#### **3.4.2.1 Surface Radiological Survey and Surface Soil Sampling**

The following work elements will be conducted at IHSS 209 and the other surface disturbances;

- an HPGe survey of portions of IHSS 209 and the other surface disturbances be conducted (Figures 3.4.2.1-1 and 3.4.2.1-2),
- HPGe anomalies will then be FIDLER surveyed to identify the locations with the greatest activity, and
- surface soil samples will then be collected from these locations and analyzed for plutonium-239/240 and americium-241.

To provide full HPGe coverage of the areas of interest it is recommended that a grid spacing of 70 ft be used in conjunction with an HPGe field of view of 100 ft in diameter. In addition to providing full coverage this geometry also reduces the size of the areas to be FIDLER surveyed to a manageable size. Assuming that each HPGe survey station will require 1 hour, all three areas of interest could be surveyed in about 5 weeks. After the HPGe data are processed and anomalies identified, FIDLER surveys will be designed.

---

**Technical Memorandum No. 15**  
**Amended Field Sampling Plan**  
**Volume 1**

**Manual:** 21100-WP-OU05.1  
**Section:** 3.0, Rev. 0  
**Page:** 3-28  
**Organization:** ER OU 5, 6 & 7 Closures

---

The FIDLER survey will be conducted in accordance with SOP FO.16, Surface Radiological Measurements, as modified by Document Change Notice (DCN) 93.01, and Environmental Management Radiological Guideline 6.6, as modified by DCN 93.01. These surveys will be performed by establishing a square grid across an anomaly. Lines on 4-foot spacing will then slowly walked while slowly moving the FIDLER in an arcing motion. The display on the FIDLER will be carefully watched during this process so as to observe any deflections from background levels. If readings in excess of background are detected, a survey confined to a smaller area will be completed to attempt to identify the source(s) of the radiation detected.

A surface soil sampling program will be designed based upon the results of the FIDLER survey(s). A surface soil sample will be collected from each anomaly identified by the FIDLER survey. If the FIDLER survey does not identify any sources of anomalous radiation within the HPGe anomalies, three surface soil samples will be collected randomly within each HPGe anomaly. The surface soil samples will be collected using the Rocky Flats Method and will be analyzed for plutonium-239/240 and americium-241. The number of surface soil samples to be collected would be proposed to EPA and CDH in a brief letter report. This report will summarize the results of both the HPGe survey and the FIDLER survey(s) and proposed surface soil sampling locations.

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual: 21100-WP-OU05.1  
Section: 4.0, Rev. 0  
Page: 4-1  
Organization: ER OU 5, 6 & 7 Closures

---

#### 4.0 REFERENCES

- Cowherd, Jr., C., G.E. Muleski, P.J. Englehart, D.A. Gillette, 1985, *Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites*. Washington, DC: USEPA, Office of Health and Environmental Assessment.
- Department of Energy (DOE), 1992. *Final Phase I RFI/RI Work Plan for Rocky Flats Plant Woman Creek Priority Drainage (Operable Unit No. 5)*, Revision 1, Rocky Flats Plant, Golden, Colorado, February, 1992.
- EG&G Rocky Flats, Inc. (EG&G), 1992a Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-FO, Volume I: Field Operations. March 1, 1992.
- EG&G, 1992b Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-GW, Volume II: Groundwater. March 1, 1992.
- EG&G, 1992c Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-GT, Volume III: Geotechnical. March 1, 1992.
- EG&G, 1992d Environmental Management Department (EMD) Operating Procedures, Manual No. 5-21000-OPS-SW, Volume IV: Surface Water. March 1, 1992.
- EG&G, 1992e *Phase II Geologic Characterization - Data Acquisition, Final Report*, Prepared for the U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, March 1992.
- EG&G, 1993a, *Background Geochemical Characterization Report, Rocky Flats Plant*, Prepared for the U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, September, 1993.
- EG&G, 1993b, Final Technical Memorandum 1, Addendum to Final Phase I RFI/RI Work Plan, *Revised Network Design - Field Sampling Plan*, May, 1993.
- EG&G, 1993c, Final Technical Memorandum 6, Addendum to Final Phase I RFI/RI Work Plan, *Cone Penetrometer Testing and Groundwater Sampling Plan - IHSS 115*, March, 1993.

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual: 21100-WP-OU05.1  
Section: 4.0, Rev. 0  
Page: 4-2  
Organization: ER OU 5, 6 & 7 Closures

---

EG&G, 1993d, Final Technical Memorandum 4, Addendum to Final Phase I RFI/RI Work Plan, *Surface Soil Sampling Plan - Ash Pits, Incinerator and Concrete Wash Pad*, April, 1993.

EG&G, 1993e, Final Technical Memorandum 7, Addendum to Final Phase I RFI/RI Work Plan, *Soil Boring Sampling Plan - Ash Pits 1-4, Incinerator and Concrete Wash Pad*, February, 1993.

EG&G, 1993f, Final Technical Memorandum 9, Addendum to Final Phase I RFI/RI Work Plan, *Monitoring Well Installation Plan - IHSS 133*, June, 1993.

EG&G, 1993g, *Model Descriptions for Operable Unit No. 5, Human Health Risk Assessment*, Technical Memorandum No. 13, Addendum to Final Phase-I RFI/RI Work Plan, Prepared for EG&G Rocky Flats, Inc., November 29, 1993 (draft final).

EG&G, 1993h, Final Technical Memorandum 10, Addendum to Final Phase I RFI/RI Work Plan, *Soil Sampling Plan - Surface Disturbance Areas*, March, 1993.

EG&G, 1993i, *Human Health Risk Assessment Exposure Scenarios Rocky Flats Plant Woman Creek Priority Drainage (Operable Unit No. 5)*, Technical Memorandum No. 12, Draft Revision 0. Golden, Colorado: EG&G Rocky Flats, Inc.

EG&G, 1993j, *Assessment and Integration of Radioactive Ambient Air Monitoring at Rocky Flats Plant*. Golden, Colorado.

EG&G, 1994a, *Hydrologic Data Summary, Phase I RFI/RI Site Characterization, Compilation and Assessment of Hydrology, Water-Quality and Bottom-Sediment Chemistry Data, Rocky Flats Plant, Woman Creek Priority Drainage (Operable Unit No. 5)*, Revised Draft Final, March, 1994.

EG&G, 1994b, *OU3 Wind Tunnel Study Volume I: Test Report*. Prepared by Midwest Research Institute under DOE Prime Contract No. DE-AC04-90DP62349, Subcontract No. ASC218973GG, MRI Project No. 3155-M, January 24, 1994. Golden, Colorado: EG&G Rocky Flats, Inc.

EG&G, 1994c, *Environmental Management Radiological Guidelines* Revision 4 (Manual No. 3-21000-OPS-EMRG). Golden, Colorado: EG&G Rocky Flats, Inc.

---

Technical Memorandum No. 15  
Amended Field Sampling Plan  
Volume 1

Manual: 21100-WP-OU05.1  
Section: 4.0, Rev. 0  
Page: 4-3  
Organization: ER OU 5, 6 & 7 Closures

---

Eklund, B.M., M.R. Keinbusch, D. Ranum, and T. Harrison. No date. *Development of a Sampling Method for Measuring VOC Emissions from Surface Impoundments*. Austin, TX: Radian Corporation.

U.S. Environmental Protection Agency (EPA), 1988, *Research and Development Aerial Photographic Analysis Comparison Report, Rocky Flats, Golden, Colorado*, TS-PIC-99760, Appendix A, EPA Region 8, July, 1988.

EPA, 1989, *Air/Superfund National Technical Guidance Study Series Volume II - Estimation of Baseline Air Emissions at Superfund Sites* Interim Final (EPA-450/1-89-002). Research Triangle Park, NC: Office of Air Quality Planning and Standards.

Fedors, R. and Warner, J. W., 1993, *Characterization of Physical and Hydrologic Properties of Surficial Materials and Groundwater/Surface Water Interaction Study at Rocky Flats Plant, Golden, Colorado*, Groundwater Technical Report #21, Colorado State University, Fort Collins, Colorado, July, 1993.

Jacobs Engineering Group (Jacobs), 1994, *Draft Technical Memorandum Number 1, Data Compilation, Operable Unit 8*, Prepared for EG&G Rocky Flats, Inc., April, 1994 (Draft).

Table 3.1.2-1. Summary of Amended Field Sampling Plan  
IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)

Page 1 of 4

EVALUATION	ACTIVITY	NO. OF SAMPLING LOCATIONS	SAMPLING FREQUENCY	ANALYTICAL PARAMETERS	FIELD QUALITY CONTROL SAMPLES/PROGRAM	APPLICABLE SECTION OF TEXT
<b>Intrinsic Air Permeability Test Evaluation</b>	Review soil gas survey vacuum pressures, borehole logs, and analytical results	NA	NA	NA	NA	3.1.2.1
	Resample at low vacuum pressures	TBD	TBD	1,1,1-TCA benzene carbon tetrachloride DCM TCE PCE	1 duplicate/10 samples  1 syringe blank/each syringe use  instrument calibration at beginning and end of each day and every 8 hours	
<b>Geotechnical Evaluation</b>	Review information regarding existing slump	NA	NA	NA	NA	3.1.2.2
	Evaluate pre- and post-slump surface geometry	NA	NA	NA	NA	
	Evaluate subsurface geometry/geotechnical properties	5 hollow-stem auger (HSA) boreholes (one with a piezometer installed, see following page)	continuous core	field screening core logging	NA	
			discrete soil sample every third sampler (approx. 6 feet)	natural moisture content	NA	
			1 sample from last 2 feet of alluvium above bedrock	natural moisture content, natural density (dry and moist), grain-size distribution, ion-type and Atterberg limits	NA	

Table 3.1.2-1. Summary of Amended Field Sampling Plan  
IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)  
Page 2 of 4

EVALUATION	ACTIVITY	NO. OF SAMPLING LOCATIONS	SAMPLING FREQUENCY	ANALYTICAL PARAMETERS	FIELD QUALITY CONTROL SAMPLES/PROGRAM	APPLICABLE SECTION OF TEXT
Geotechnical Evaluation (cont.)	Evaluate Subsurface geometry/geotechnical properties (cont.)		1 soil sample of each material type (waste, alluvium, and bedrock) from each borehole	6 selected samples (2 of each material type) for natural density (moist and dry), nat. moisture content, grain-size dist., ion type, and UU test or direct shear test	NA	3.1.2.2
		1 piezometer (HSA borehole advanced as discussed on preceding page)	monthly	water level	replicate measurements as specified in SOP GW.01	
		8 small diameter (Kansas Sampler) boreholes (1 with a piezometer installed, see below)	continuous core	field screening core logging	NA	
			discrete sample every third sampler (approx. 6 feet)	natural moisture content	NA	
			1 sample from last 2 feet of alluvium above bedrock	natural moisture cont. grain-size dist., ion type, and Atterberg limits	NA	
		1 piezometer (small diameter borehole advanced as above)	monthly	water level	replicate measurements as specified in SOP GW.01	
	Waste and core characterization	5 HSA boreholes	1 drum composite per drum (approx. 1 drum per 10 ft. of borehole)	TCL VOCs, SVOCs, Pest. & PCBs, TAL Metals, and Radionuclides	1 dup/10 samples and 1 rinsate/20 samples or minimum of 1 rinsate/day	
		TBD - minimum of 2 small diameter boreholes (twins)	2-foot discrete samples	TCL VOCs	1 dup/10 samples and 1 rinsate/20 samples or minimum of 1 rinsate/day	
			6-foot composite samples or alternative composites as specified in TM7	Radionuclides, TAL metals, SVOCs and pesticides & PCBs		



Table 3.2.2-1. Summary of Amended Field Sampling Plan  
IHSS 133 (Ash Pits, Incinerator, and Concrete-wash Pad)  
Page 1 of 1

EVALUATION	ACTIVITY	NO. OF SAMPLING LOCATIONS	SAMPLING FREQUENCY	ANALYTICAL PARAMETERS	FIELD QUALITY CONTROL SAMPLES/PROGRAM	APPLICABLE SECTION OF TEXT
<b>Investigation of TDEM Anomalies</b>	Comprehensive field inspection	NA	NA	NA	NA	3.2.2.1
	Soil boreholes	7	6-foot composite samples or alternative composites as specified in TM7	TAL metals and radionuclides	1 duplicate/10 samples and 1 rinsate/20 samples or minimum of 1 rinsate/day	
	Collection of geotechnical samples	TBD	10 percent of total number of composite samples	grain-size distribution (+200 fraction)	NA	
	Collection of groundwater samples from soil boreholes	TBD (1/location with water)	once	TAL metals and radionuclides	1 duplicate/10 samples (none anticipated) and 1 rinsate/20 samples or minimum of 1 rinsate/day	
<b>Groundwater Investigation</b>	Advance soil boreholes and install piezometers (mini-wells)	9	every third sampler (approx. 6 feet)	natural moisture content	NA	3.2.2.2
	Measure water levels	TBD	monthly	water level	replicate measurements as specified in SOP GW.01	
	Sample piezometers	TBD	quarterly	TAL metals, SVOCs, pesticides, PCBs, and radionuclides	1 duplicate/10 samples (none anticipated) and 1 rinsate/20 samples or minimum of 1 rinsate/day (rinse probes)	
	Visual survey of Woman Creek stream channel	NA	NA	NA	NA	
	Aquifer tests	1	once	NA	NA	
<b>Air Monitoring</b>	RAAMP Monitoring	Monitoring will be conducted as specified in RAAMP documentation.				3.2.2.3
	Special OU5 Ambient Air Samplers	3	bi-weekly samples composited monthly	Radionuclides	As specified in SOP AP.13	
	Wind Resuspension	TBD	TBD	TBD	TBD	

NA = Not Applicable      TBD = To Be Determined

Table 3.4.2-1. Summary of Amended Field Sampling Plan  
IHSS 209 and Other Surface Disturbances  
Page 1 of 1

EVALUATION	ACTIVITY	NO. OF SAMPLING LOCATIONS	SAMPLING FREQUENCY	ANALYTICAL PARAMETERS	FIELD QUALITY CONTROL SAMPLES/PROGRAM	APPLICABLE SECTION OF TEXT
Surface Radiological Survey and Surface-Soil Sampling	HPGe survey	TBD	70-foot grid	NA	NA	3.4.2.1
	FIDLER survey	TBD	4-foot line spacing	NA	NA	
	Surface-soil sampling	TBD	1/FIDLER anomaly or 3/HPGe anomaly if FIDLER anomaly cannot be identified	Plutonium-239/240 and americium-241	1 duplicate/10 samples and 1 rinseate/20 samples or minimum of 1 rinseate/day.	
NA = Not Applicable		TBD = To Be Determined				

Table 3.1.2.3-1. Analysis Parameters, Sequence of Collection, and Order of Priority for Groundwater Samples<sup>1</sup>

<u>Parameter (in order of priority)</u>	<u>Minimum Volume</u>
• Radiation Screening	6 oz (180 ml)
• TCL VOCs	2 - 40 ml
• Dissolved Uranium-233/234, Uranium-235, and Uranium-238	100 ml*
• Americium-241	1 L
• Plutonium-239/240	1 L
• Field Test Parameters:	
• Ph, Conductivity, and Temperature	35 ml
• Dissolved Metals - CLP w/ Cs, Li, Sr, Sn, Mo, Si	1 L*
• BNA (Base Neutral Acid)	1 L (1000 ml)
• Pesticides / PCB	1 L
• Dissolved Gross Alpha and Gross Beta	550 ml*
• <sup>3</sup> H	100 ml
• TSS (Total Suspended Solids)	125 ml
• TOC (Total Organic Carbon)	125 ml
• COD (Chemical Oxygen Demand)	125 ml
• Orthophosphate (filtered)	250 ml*
• Nitrate / Nitrite as N	250 ml
• Dissolved Strontium-89/90	700 ml*
• Dissolved Radium-226/228	750 ml*
• TDS, Cl, F, SO <sub>4</sub> , CO <sub>3</sub> , HCO <sub>3</sub>	1 L
• Cyanide	1 L
• Dissolved Cesium-137	2.5 L (2500 ml)*

\* = On-site filtered sample (0.45-micrometer filter)

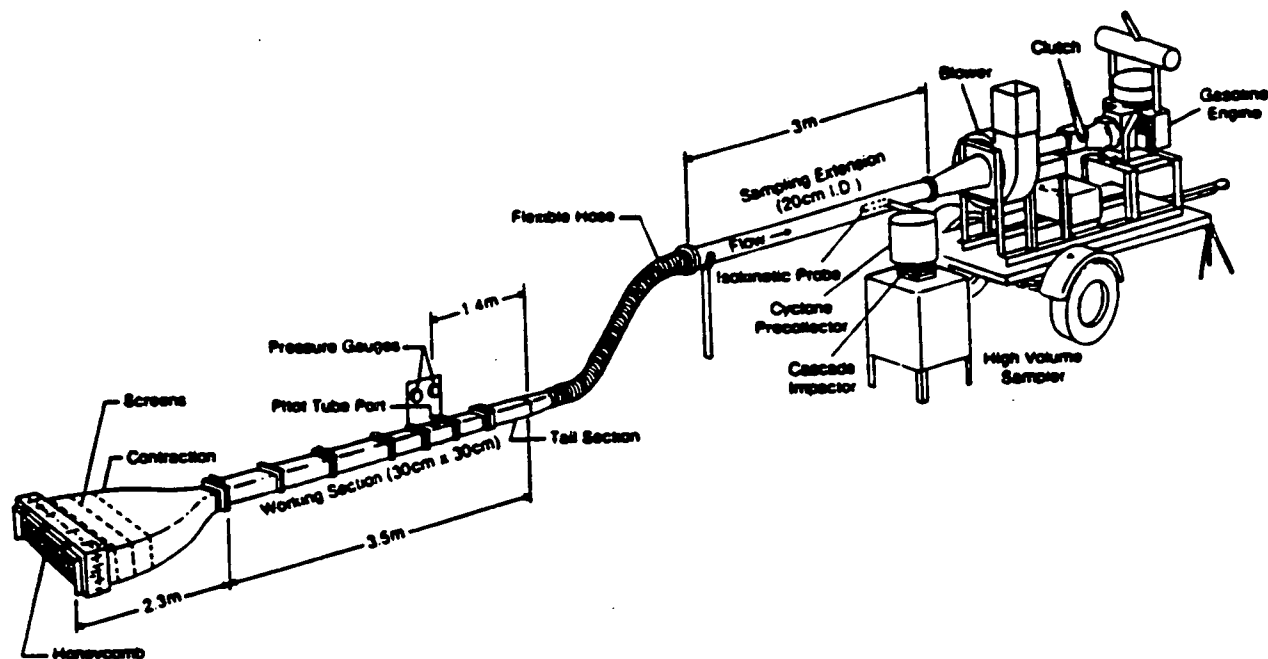
<sup>1</sup> See Tables 3.1.2-1, 3.2.2-1, and 3.4.2-1 for lists of analytes for samples to be collected.

Table 3.1.2-1. Summary of Amended Field Sampling Plan  
IHSS 115 (Original Landfill) and IHSS 196 (Filter Backwash Pond)  
Page 3 of 4

EVALUATION	ACTIVITY	NO. OF SAMPLING LOCATIONS	SAMPLING FREQUENCY	ANALYTICAL PARAMETERS	FIELD QUALITY CONTROL SAMPLES/PROGRAM	APPLICABLE SECTION OF TEXT
Geotechnical Evaluation (cont.)	Back calculate strength parameters and calculate long-term stability by method of slices.	NA	NA	NA	NA	3.1.2.2
Groundwater Investigation	Install and sample mini-wells	5	2-foot discrete soil samples	TCL VOCs	1 dup/10 samples and 1 rinsate/20 samples or minimum of 1 rinsate/day	3.1.2.3
			6-foot composite soil samples or alternative composites as specified in TM7	SVOCs, Pesticides & PCBs, TAL Metals, and Radionuclides		
			Groundwater - quarterly	TCL VOCs, SVOCs, Pesticides & PCBs, TAL Metals, and Radionuclides		
	Measure water levels	46	monthly	water level	replicate measurements as specified in SOP GW.01	
	Sample existing well points	TBD	quarterly	TCL VOCs, SVOCs, Pesticides & PCBs, TAL Metals, and Radionuclides	1 dup/10 samples and 1 rinsate/20 samples or minimum of 1 rinsate/day	
	Characterize bedrock surface and install piezometers	3	continuous core	field screening core logging	NA	
	Aquifer tests	1	once	NA	NA	

Page 4 of 4

NA = Not Applicable      TBD = To Be Determined



Source: USEPA 1989.

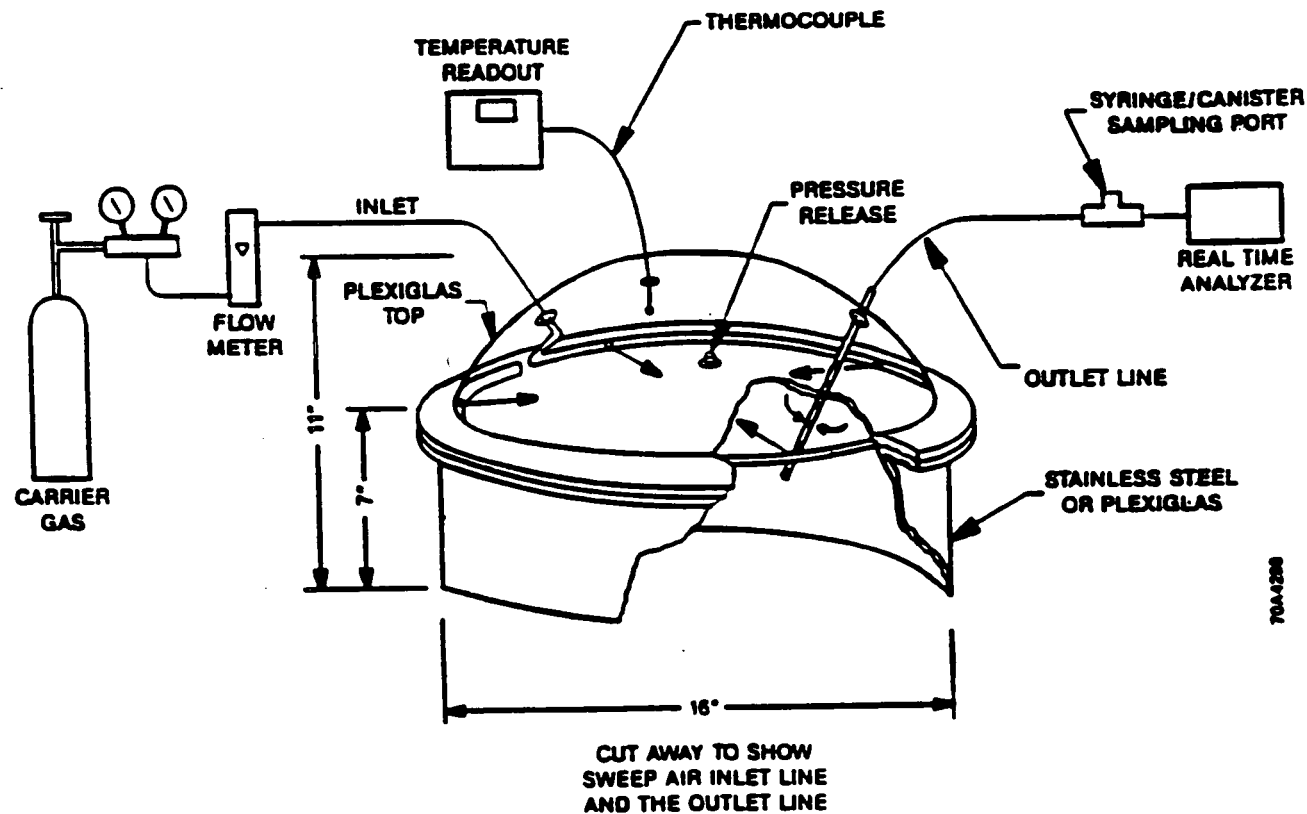
Cowherd Wind Tunnel



RFP, OU5 RFI/RI, TM15  
WOMAN CREEK PRIORITY DRAINAGE

FIGURE 3.1.2.4-1

DRAWN	DATE
CHECKED	DATE
APPROVED EG&G	DATE
APPROVED DOE	DATE



Source: USEPA 1989.

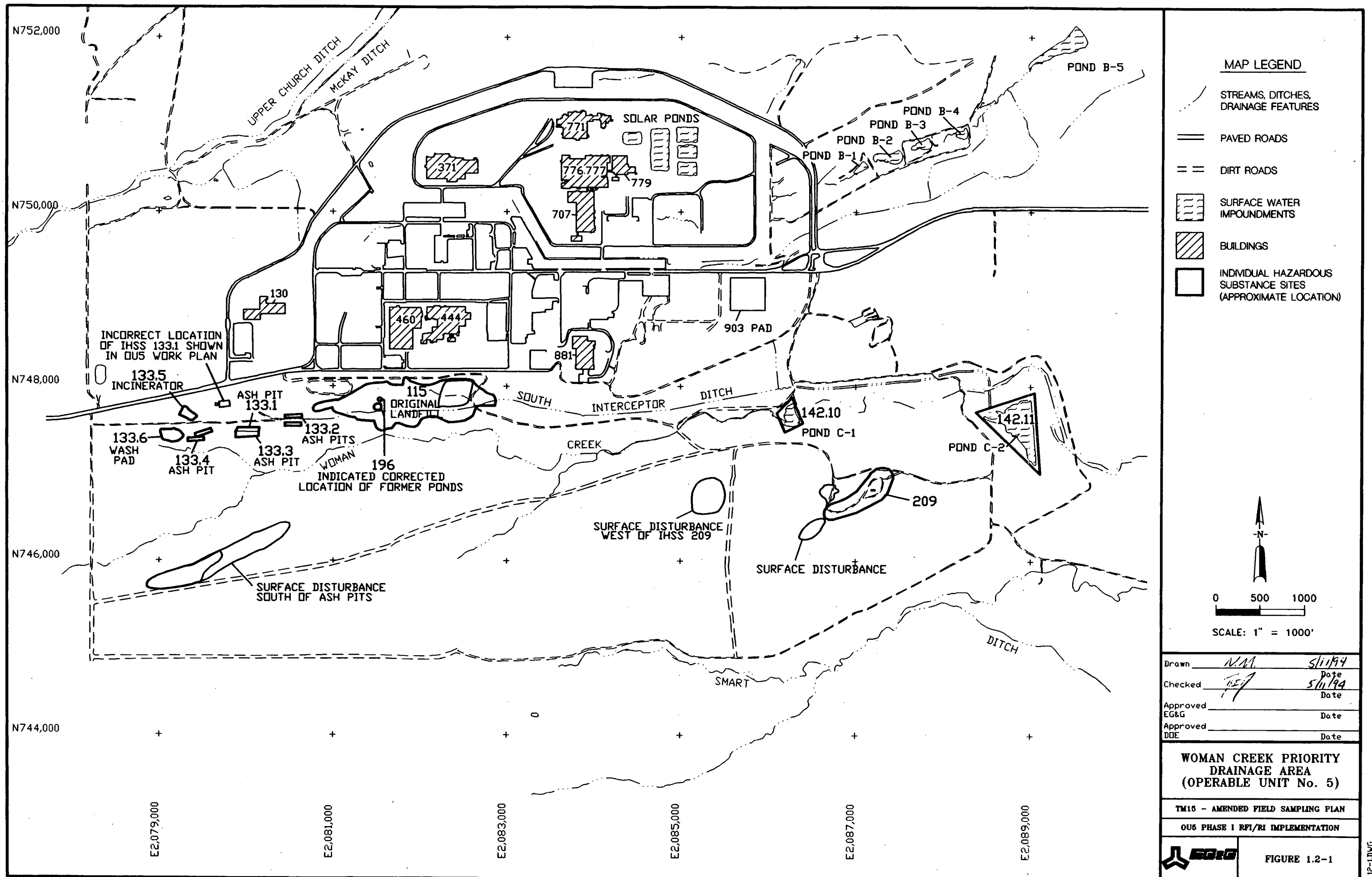
### Emission Isolation Flux Chamber and Support Equipment



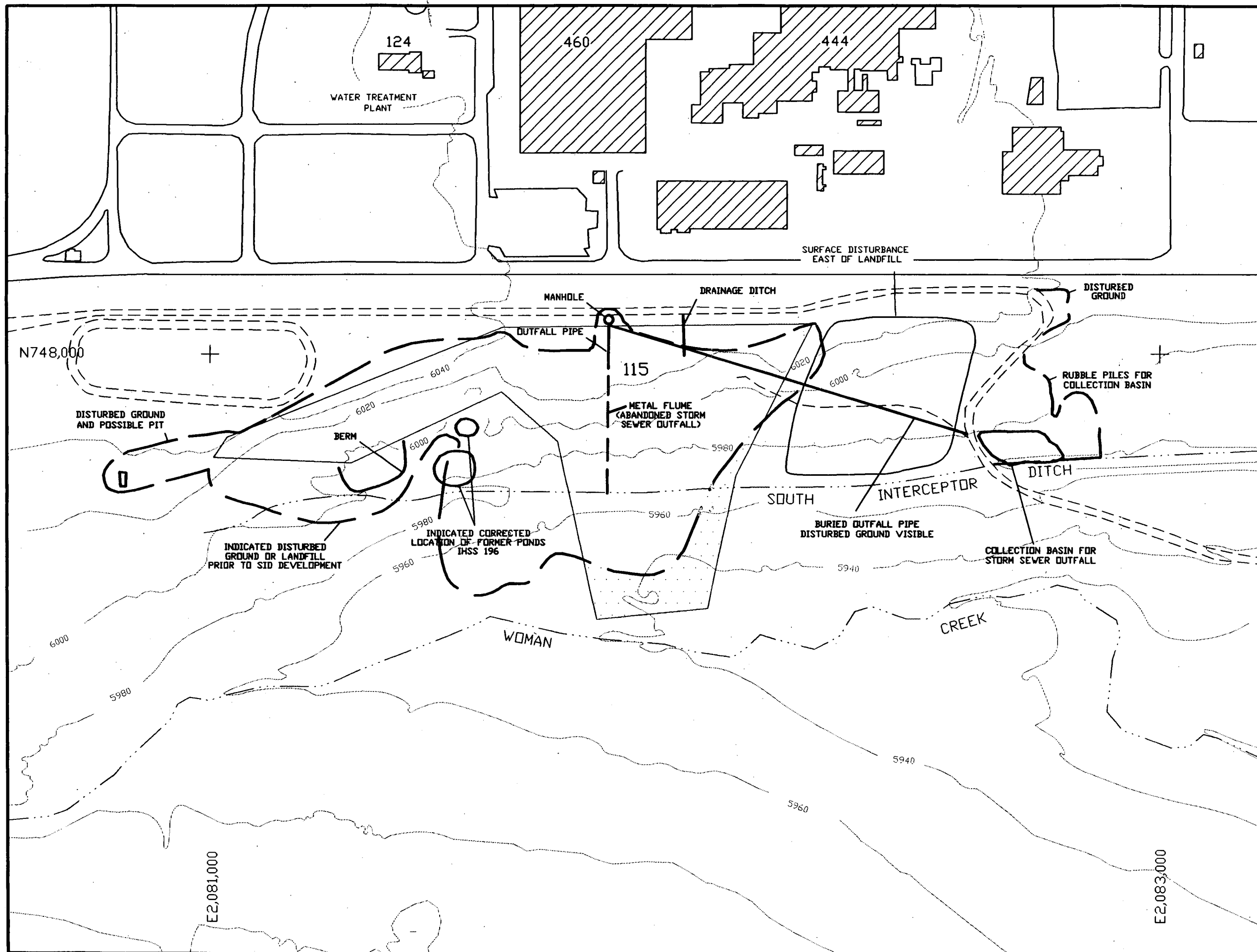
RFP, OU5 RFI/RI, TM15  
WOMAN CREEK PRIORITY DRAINAGE

FIGURE 3.1.2.4-2

DRAWN	DATE
CHECKED	DATE
APPROVED BO&O	DATE
APPROVED DOE	DATE







**MAP LEGEND**

- STREAMS, DITCHES, DRAINAGE FEATURES
- PAVED ROADS
- DIRT ROADS
- BUILDINGS
- IHSS 115 ORIGINAL LANDFILL BOUNDARY (DOE, 1992)
- AMENDED LANDFILL BOUNDARY BASED ON AERIAL PHOTO REVIEW
- EPA AND CDH SOUTHERN EXTENSION OF LANDFILL BOUNDARY (DOE, 1992) INCLUDED IN THIS STUDY

0 100 200  
SCALE: 1" = 200'

Drawn *N.M.* 5/11/94  
Checked *J.P.* 5/11/94  
Approved EG&G \_\_\_\_\_ Date \_\_\_\_\_  
Approved DOE \_\_\_\_\_ Date \_\_\_\_\_

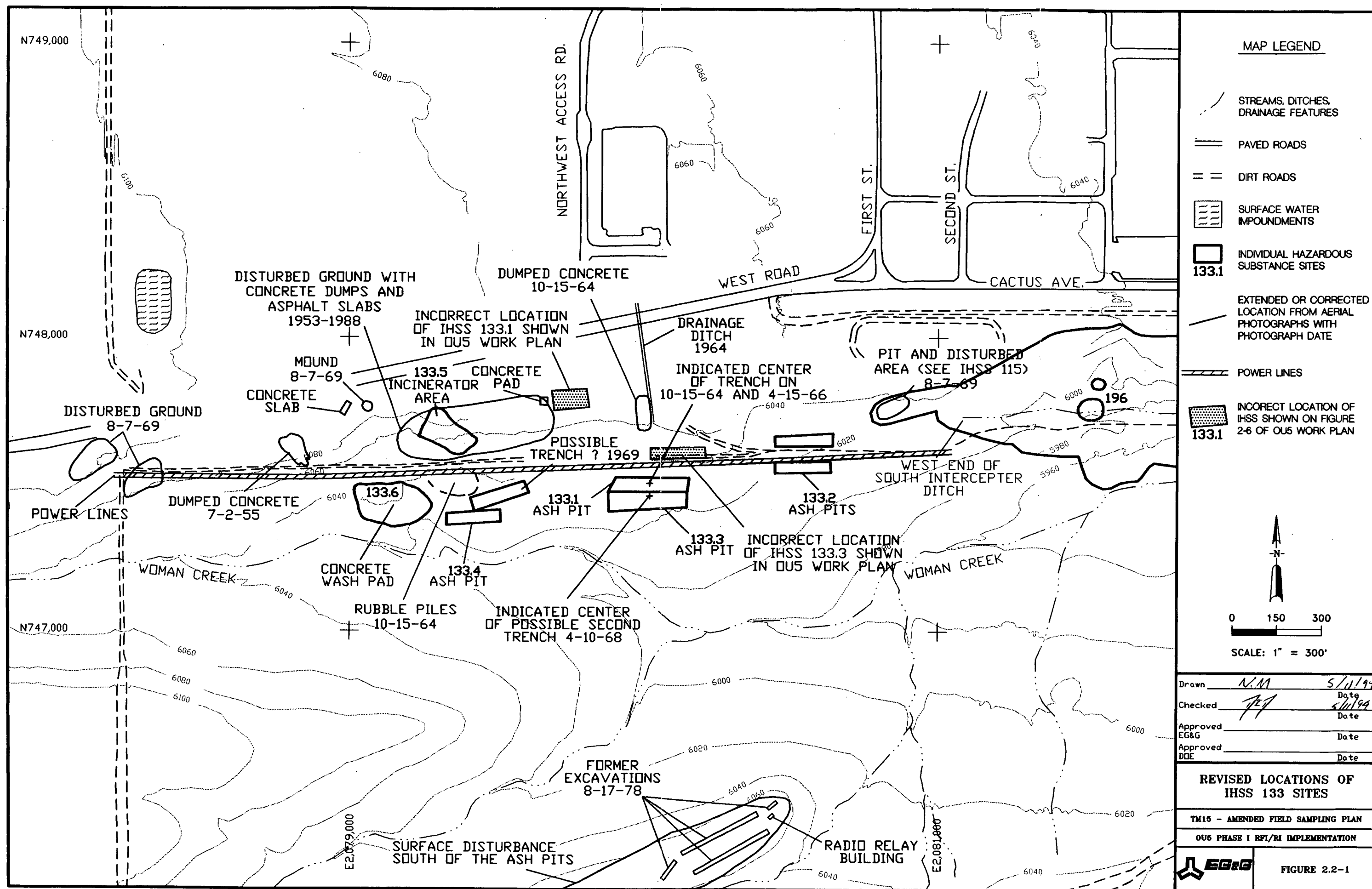
**IHSS 115 ORIGINAL LANDFILL AND EXTENDED AREAS AND IHSS 196 FILTER BACKWASH POND**

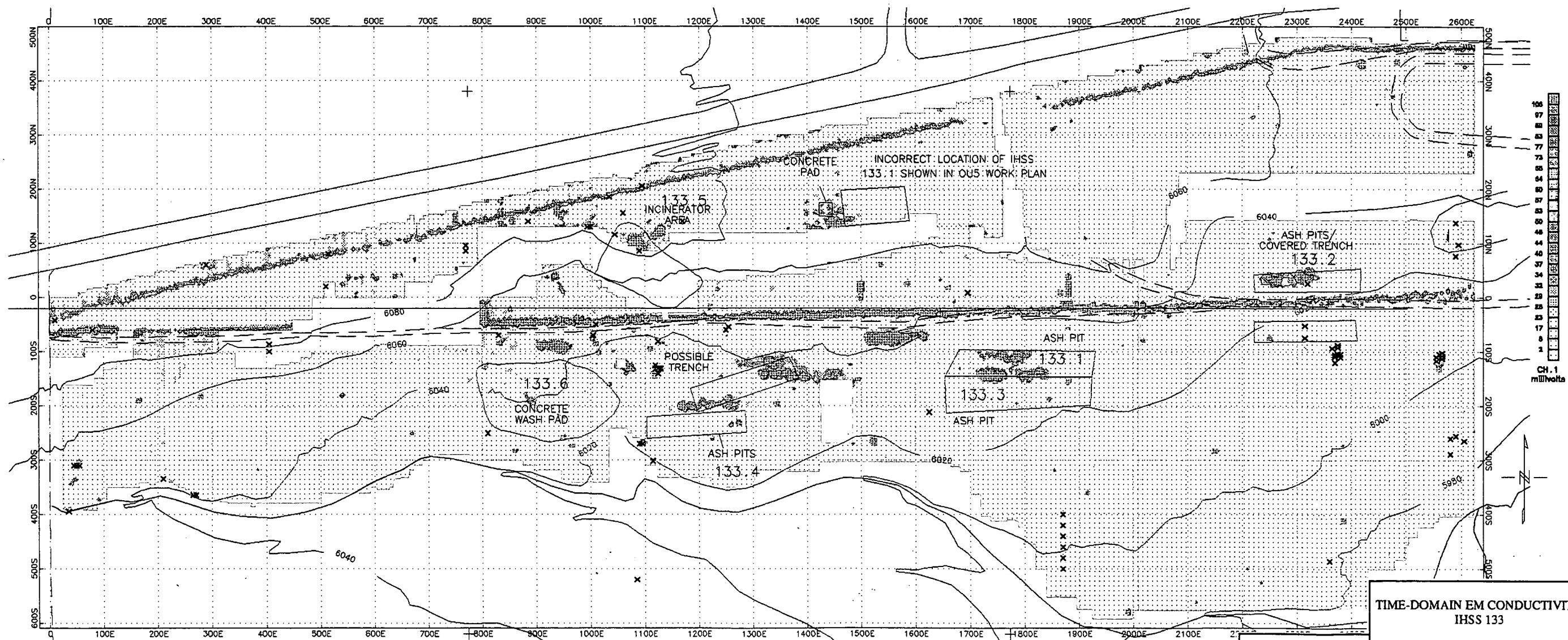
TM15 - AMENDED FIELD SAMPLING PLAN

OU6 PHASE I RFI/RI IMPLEMENTATION

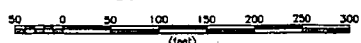
**FIGURE 2.1-1**

PAGE 12





Scale 1:2400

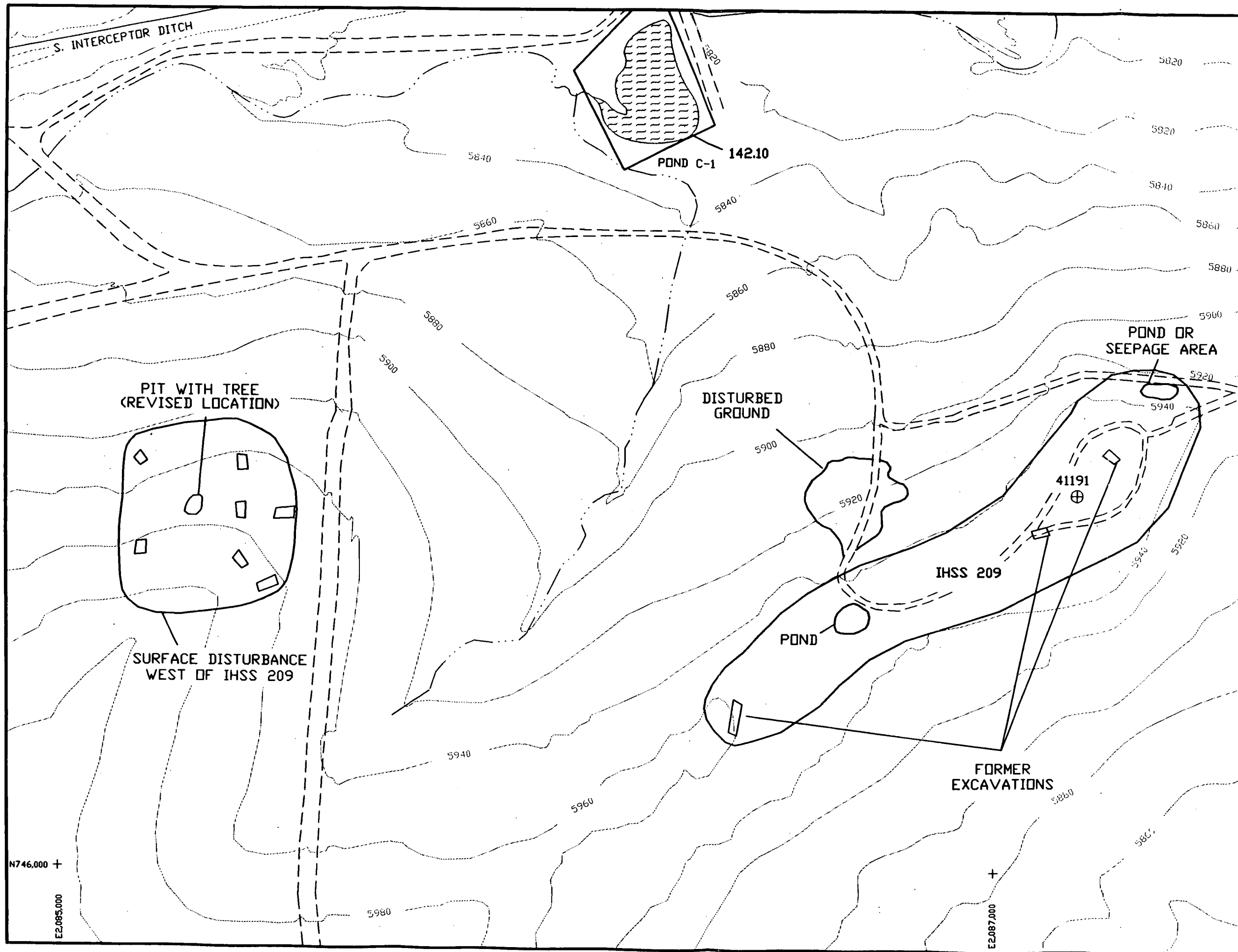


**TIME-DOMAIN EM CONDUCTIVITY  
IHSS 133**







TM15 - AMENDED FIELD SAMPLING PLAN  
OUS PHASE I RFI/RI IMPLEMENTATION

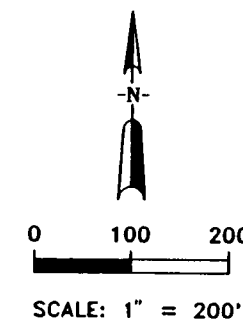
	MAY 1994	FIGURE
		2.2.2.2-1

DRAWN _____	DATE _____
CHECKED _____	DATE _____
APPROVED EG&G _____	DATE _____
APPROVED DOE _____	DATE _____



#### MAP LEGEND

-  STREAMS, DITCHES, DRAINAGE FEATURES
-  DIRT ROADS
-  SURFACE WATER IMPOUNDMENTS
-  REVISED PIT LOCATIONS
-  INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)
-  41191 EXISTING BOREHOLE



Drawn	N.M.	5/11/94
Checked	J.P.	5/11/94
Approved EG&G		
Approved DOE		

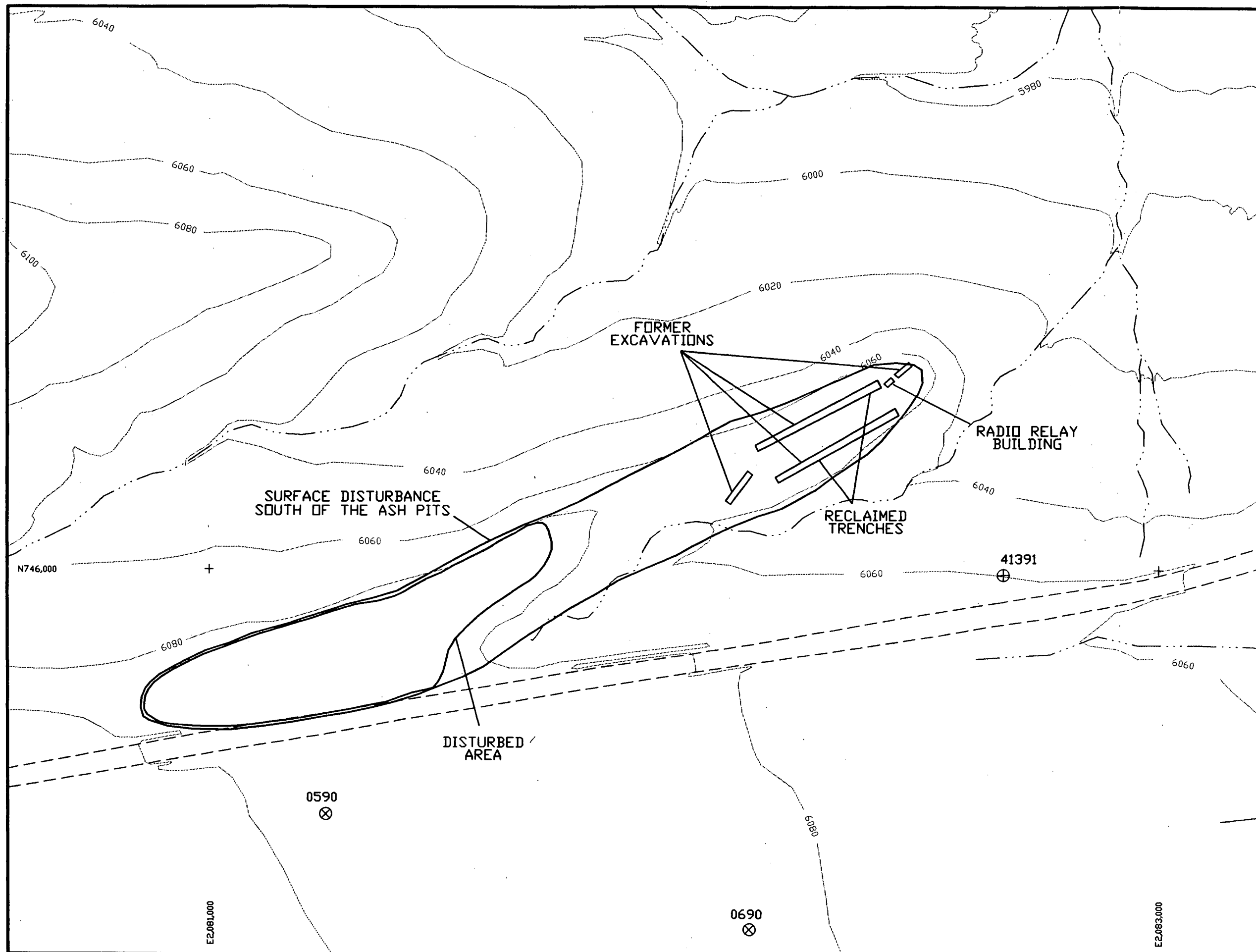
**IHSS 209 &  
SURFACE DISTURBANCE  
WEST OF IHSS 209  
LOCATION MAP**

TM16 - AMENDED FIELD SAMPLING PLAN

OU6 PHASE I RPI/RI IMPLEMENTATION



FIGURE 2.4-1



# MAP LEGEND

STREAMS, DITCHES, DRAINAGE FEATURES

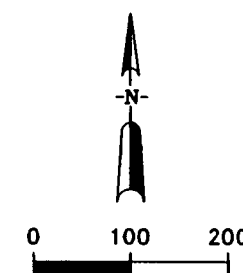
DIRT ROADS

SURFACE WATER IMPOUNDMENTS

INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)

41391 EXISTING BOREHOLE

0690 EXISTING MONITORING WELLS



SCALE: 1" = 200'

Drawn	N.M.	5/11/94
Checked	J.P.	5/11/94
Approved		
EG&G		
Approved		
DOE		

SURFACE DISTURBANCE SOUTH OF THE ASH PITS LOCATION MAP

TM15 - AMENDED FIELD SAMPLING PLAN

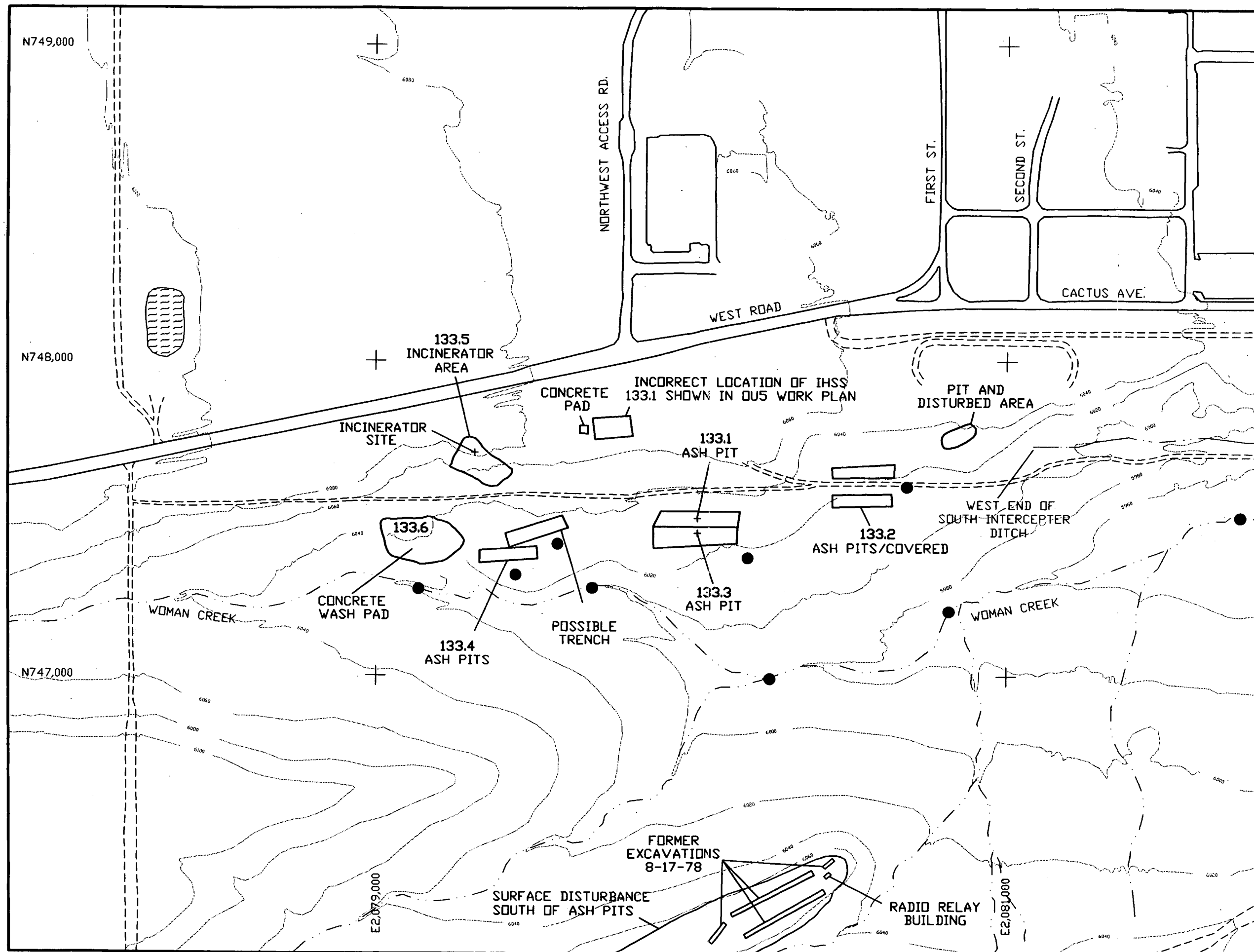
OU5 PHASE I RFI/RI IMPLEMENTATION



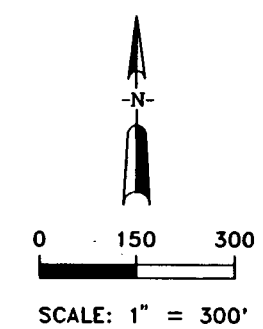
FIGURE 2.4-2







- MAP LEGEND**
- STREAMS, DITCHES, DRAINAGE FEATURES
  - PAVED ROADS
  - DIRT ROADS
  - SURFACE WATER IMPOUNDMENTS
  - INDIVIDUAL HAZARDOUS SUBSTANCE SITES 133.1
  - PROPOSED MONITORING WELLS (MINI-WELLS)



Drawn	N.M.	5/11/94
Checked	J.F.	5/11/94
Approved EG&G		Date
Approved DOE		Date

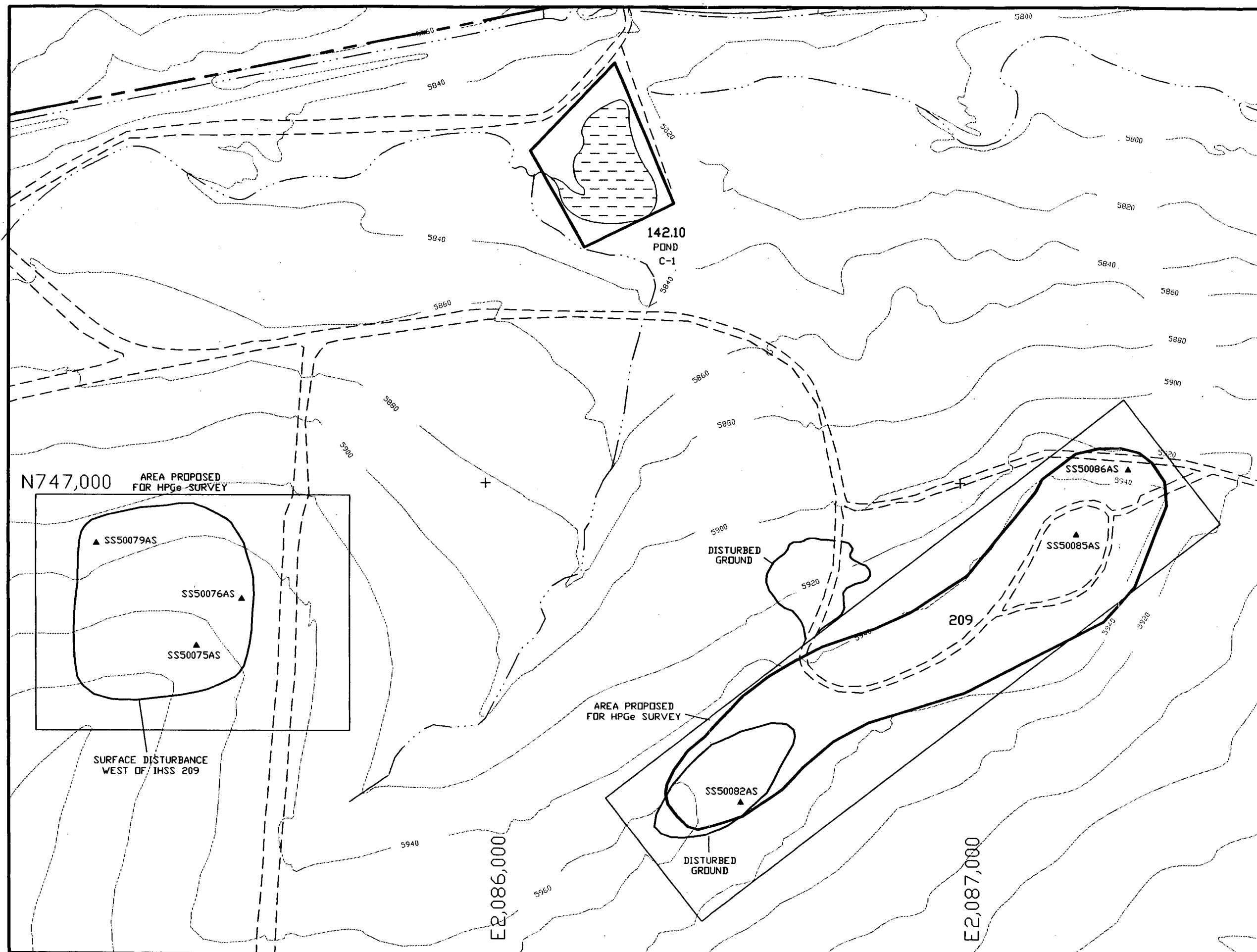
**PROPOSED WELL POINT AND MONITORING WELL LOCATION MAP IHSS 133**

TM15 - AMENDED FIELD SAMPLING PLAN

OUS PHASE I RFI/RI IMPLEMENTATION

**FIGURE 3.2.2.2-1**





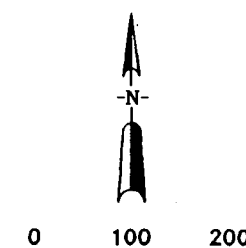
# MAP LEGEND

STREAMS, DITCHES,  
DRAINAGE FEATURES

= = DIRT ROADS

**209** INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES (IHSS)

SS50085AS  
▲ SURFACE SOIL SAMPLE  
LOCATION WITH ACTIVITY  
ABOVE THE BUTL



SCALE: 1" = 200'

Drawn	N.M.	5/11/94
Checked	J.S.P.	5/11/94
Approved		
EG&G		
Approved		
DOE		

**PROPOSED HPGe SURVEY  
LOCATIONS IHSS 209 AND  
AND SURFACE DISTURBANCE  
WEST OF IHSS 209**

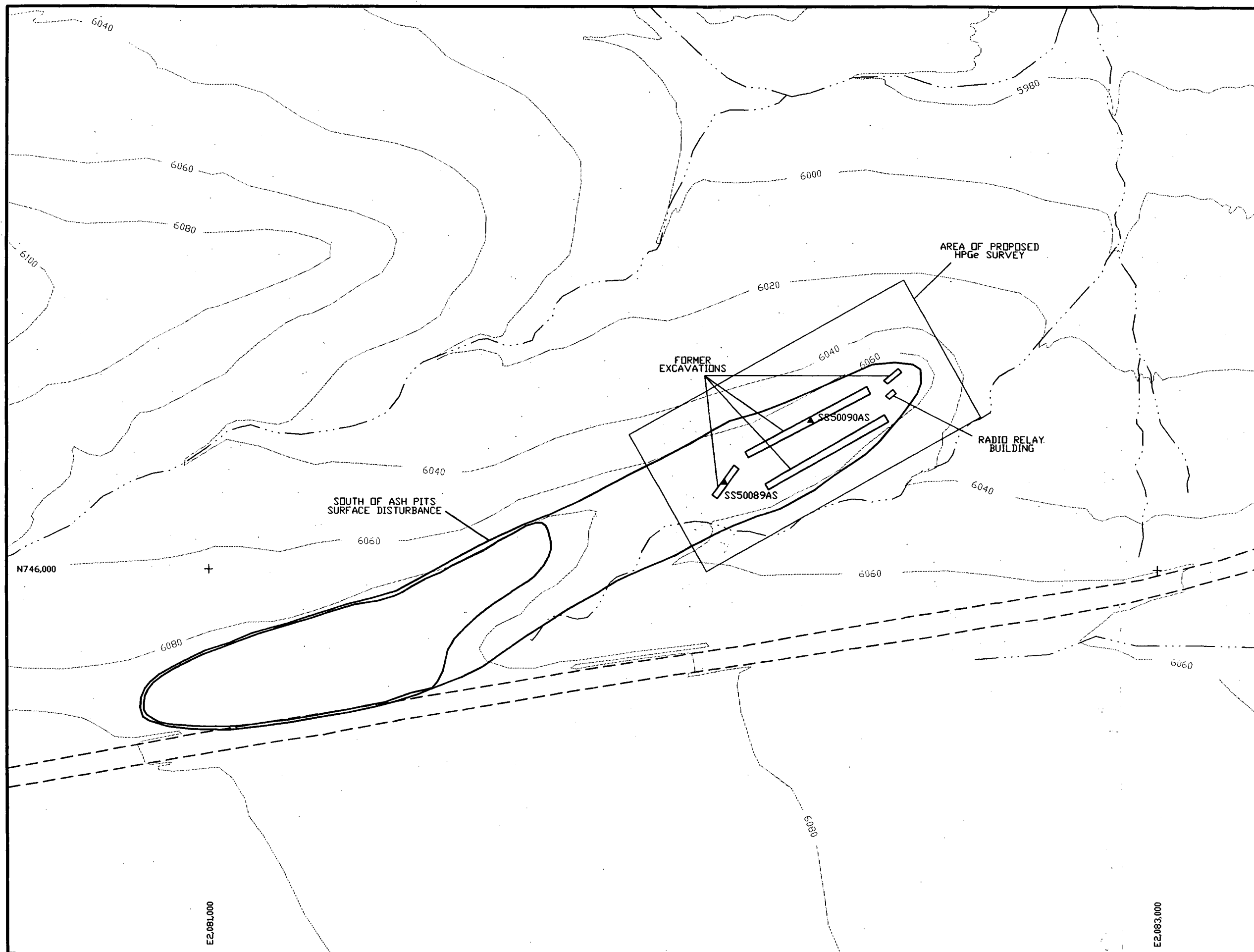
TM15 - AMENDED FIELD SAMPLING PLAN

OU6 PHASE 1 RFI/RI IMPLEMENTATION



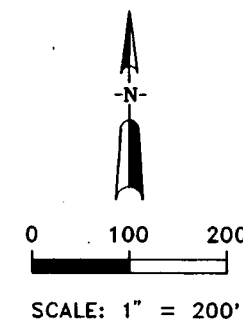
FIGURE 3.4.2.1-1

DB209B.DWG



**MAP LEGEND**

- STREAMS, DISTICHES, DRAINAGE FEATURES
- DIRT ROADS
- INDIVIDUAL HAZARDOUS SUBSTANCE SITES (IHSS)
- SS50089AS SURFACE SOIL SAMPLE LOCATION WITH ACTIVITY ABOVE THE BUTL



Drawn	N. M.	5/11/94
Checked	<i>[Signature]</i>	5/11/94
Approved		
EG&G		
Approved		
DDE		

**PROPOSED HPGe SURVEY  
SURFACE DISTURBANCE  
SOUTH OF THE ASH PITS**

TM15 - AMENDED FIELD SAMPLING PLAN

OU6 PHASE I RFI/RI IMPLEMENTATION



FIGURE 3.4.2.1-2

ADB209ADWG